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CHICKAMAUGA BLUFF, LOOKOUT MOUNTAIN, WALKER COUNTY, GEORGIA,
SHOWING A TYPICAL BLUFF OF LOOKOUT SANDSTONE.

GEOLOGICAL SURVEY OF GEORGIA

W. S. YEATES, State Geologist

BULLETIN No 12.

A PRELIMINARY REPORT

ON THE

COAL DEPOSITS

OF

GEORGIA

BY

S. W. McCALLIE

Assistant Geologist



1904

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LETTER OF TRANSMITTAL

GEOLOGICAL SURVEY OF GEORGIA,
ATLANTA, January 2nd, 1904.

To His Excellency, J. M. TERRELL, Governor,

SIR :—I have the honor to submit a report by Mr. S. W. McCallie, Assistant Geologist, on the Coal Deposits of Georgia, to be published as Bulletin No. 12 of this Survey.

Very respectfully yours,

W. S. YEATES,
State Geologist.

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Map Showing the Distribution of the Coal Measures of Northwest Georgia, together with the Associated Rocks.

THE COAL DEPOSITS OF GEORGIA

CHAPTER I

THE CARBONIFEROUS ROCKS OF GEORGIA

The Carboniferous rocks of Georgia are confined to the north-western part of the State. They are best developed in Dade, Walker and Chattooga counties; though considerable areas occur in Floyd, Gordon, Whitfield and Catoosa. In addition to the above areas, there are four or five small isolated patches of the lowest member of the Carboniferous rocks, in the western part of Polk county.¹ The latter exposure appears to be a remnant of once extensive Carboniferous *strata*, covering much, if not all, of the Paleozoic area of Northwest Georgia. The superficial extent of the several areas of Carboniferous rocks, here enumerated, aggregates about 500 square miles, which is only a fraction of the entire original Carboniferous area of the State.

The Carboniferous rocks of Georgia have been divided by Dr. C. W. Hayes, of the United States Geological Survey, into the following five divisions, named in the ascending order: Fort Payne Chert, Floyd Shale, Bangor Limestone, Lookout Sandstone and Walden's Ridge Sandstone.² The three first divisions, here given, belong to the Sub-Carboniferous series; while the two remaining divisions constitute the Carboniferous formation proper, or the Coal Measures.

¹ See Map opposite page 16.

² Geologic Atlas, Ringgold Folio, U. S. Geol. Surv.

THE FORT PAYNE CHERT, the lowest member of the Sub-Carboniferous rocks, takes its name from Fort Payne, Alabama, at which place it is typically developed. The formation corresponds to Safford's Siliceous Group of Tennessee,¹ and to Smith's lower division of the Sub-Carboniferous rocks of Alabama,² which he designates as Lauderdale or Keokuk Chert.

The Fort Payne Chert, as defined by Hayes, rests directly upon the Devonian Black Shale, and is limited above, by the Floyd Shale, or, where that formation is wanting, by the Bangor Limestone. The upper limit of the formation is often difficult to define. Especially is this true, where it is overlain by the Bangor Limestone. In such cases, it passes gradually into the purer limestone above, without any sudden or abrupt change. Under such conditions, it is often practically impossible to estimate the exact thickness of the formation. This accounts, in a great measure, no doubt, for the wide variation in the estimated thickness of the formation in Northwest Georgia. Hayes, who has made quite a study of the Paleozoic rocks of Georgia, Alabama and Tennessee, places the maximum thickness of the Fort Payne chert at 200 feet, while Spencer places it at 510 feet.³ The former estimate, according to my own observation, seems to be more nearly correct. However, the average thickness of the formation in Northwest Georgia would probably not exceed 150 feet. At some points in Catbosa county, and also in Whitfield, the Fort Payne chert is reported to attain a thickness of not more than 50 feet.

The Fort Payne chert is a siliceous, calcareous formation; and, as the name suggests, it carries a large quantity of cherty material. The lower beds of the formation, in places, often consist almost entirely of chert in the form of layers, varying from one to two

¹ *Geology of Tennessee*, pp. 339-351.

² *Tennessee Valley Region*, Ala. Geol. Surv., page 35.

³ *Geol. Surv. of Georgia, The Paleozoic Group*, page 52.

feet in thickness. These layers frequently have an aggregate thickness of more than 20 feet; and, at some points, where the underlying shales have been removed by erosion, they give rise to perpendicular bluffs, from 15 to 20 feet in height. The chert, forming the individual layers at the base of the formation, is sometimes quite compact; but it is generally of a porous nature, and frequently consists largely of fragments of crinoid stems. In passing along the lower to the upper beds of the formation, the cherty material gradually decreases in quantity, until it finally disappears entirely, or is represented by only a few scattered nodules in the almost pure limestone.

The limestone, which makes up the great mass of the Fort Payne formation, is in most cases quite siliceous; but, at some points, it consists of beds of almost pure calcium carbonate. Limestone, of the latter character, is to be seen at the quarry near Rising Fawn furnace, where large quantities of the stone were formerly obtained for fluxing purposes. Some beds of the limestone often contain little or no cherty nodules; nevertheless these beds, in many places, are found to carry a high percentage of silica. The siliceous material, in this case, is found, upon microscopic examination, to occur in the form of minute particles, forming small clusters or bunches, irregularly distributed throughout the calcareous mass. In the weathering of beds of this character, the surface often becomes encrusted, to the depth of a quarter of an inch or more, with a dark brown or chocolate-colored coating, consisting mainly of silica. The weathered product, when powdered, forms a very fine, sharp grit, partaking of the nature of tripoli. The following is a chemical analysis of a specimen of Fort Payne limestone, showing microscopic clusters of siliceous particles, made in the Survey laboratory, by Dr. Thomas L. Watson, formerly Assistant State Geologist:—

Calcium Carbonate.....	37.44
Magnesium Carbonate.....	25.95
Iron Sesqui-oxide.....	0.69
Alumina.....	1.38
Insoluble Residue.....	35.49
Total.....	<u>100.95</u>

Associated with the lower beds of the Fort Payne chert, often occur thin layers, or partings, of shale, varying from a few inches to a foot or more in thickness. These shales usually have a greenish color, and weather into a tough plastic clay.

The most marked, distinguishing characteristic of the Fort Payne formation is the great abundance of chert. This material is always quite plentiful along the outcropping of the formation; and it often covers the surface to the depth of several feet. This chert is readily distinguished from the Knox Dolomite chert, which it frequently closely resembles, by being fossiliferous. The fossils consist mainly of the fragments of crinoid stems; though coral and other organic remains sometimes occur. In weathering, this cherty material breaks into irregular fragments, well suited for road-surfacing.

The distribution of Fort Payne chert in Northwest Georgia is confined to narrow bands or zones, outcropping along the base of the mountains and ridges, formed of Carboniferous strata. It is well exposed at the base of Sand, Lookout and Pigeon mountains, and Taylor's ridge, as well as along the foot of Horn, John's and Lavander mountains, further to the east and south. As a general rule, the outcropping of this formation, owing to the slow weathering of its siliceous materials, gives rise to a narrow, sharp, serrated ridge, or chain of hills, running parallel with the main mountains, or ridges. In some instances, these hills, or minor ridges, sit back quite a distance from the base of the major ridges, or mountains, in which case, there is always a narrow, fertile valley intervening. The ridges, formed by the Fort Payne chert,

sometimes attain an elevation of 400 or 500 feet above the general level of the valley; and, at many points, they have received local names which are usually of a descriptive nature. Thus, Pudding ridge, of Dade county, and Shinbone ridge, of Walker, are names given to the more prominent parts of these cherty ridges.

Economically considered, the Fort Payne formation of Northwest Georgia has been supposed, heretofore, to be of but little commercial importance. With the exception of its chert, which is now being used to a considerable extent for road-surfacing, probably the most important material, of economic interest, in the formation, is its fire-clays. These clays, having resulted from the weathering of the more siliceous beds of the formation, are frequently found in considerable quantities along the slopes of the cherty ridges. A good exposure of a clay deposit, of this character, is to be seen in some old prospect-pits near the Alabama Great Southern Railroad, about one mile south of Rising Fawn. Just across the Alabama State-line, in the vicinity of Valley Head, are located the extensive fire-clay mines belonging to the Montague Clay Works, of Chattanooga. The clays here exposed are similar to those occurring near Rising Fawn, and have a like origin. Dr. Reis, in describing the clays at the former place, says: "Several qualities of clays are obtained from the mines; but they are not restricted, in any case, to certain layers. The following sample, tested, is what is known at the mines as the first-grade, and its refractory character is not by any means low."¹ The sample, here referred to by Dr. Reis, was a rather coarse-grained, white, sandy clay, showing the following chemical composition:—

¹ Geol. Surv. of Ala., *Clays of Alabama*, by Heinrich Reis, page 147.

Silica	82.040
Alumina	12.170
Ferric Oxide	trace
Lime	trace
Magnesia327
Alkalies600
Ignition	4.325
Total	<u>99.462</u>

Associated with the refractory clays here described, often occur potter's clay and halloysite. The last named mineral, according to Spencer,¹ is found on the Blivens property near Rising Fawn, and on the east side of Taylor's ridge, in the vicinity of Subligna. In addition to the clays, the Fort Payne chert, in places, carries impure deposits of limonite. These deposits, however, are usually of limited extent, and appear to be of but little commercial importance.

Gypsum, in the form of small pockets or nodular masses, also occurs at a few points in the siliceous limestones of the formation. Good hand specimens of this mineral may be collected from the dump at the west end of the railroad tunnel at Pigeon mountain.

THE FLOYD SHALE.—The Floyd Shale, as is above stated, lies immediately above the Fort Payne Chert, and is so called from the county of Floyd, where it is well developed. The formation, which is always valley-making, covers a considerable area both in Chattooga and in Floyd counties; and, according to Spencer, it has a thickness of 1,500 feet.² The Floyd Shale, as the name implies, consists chiefly of shales; though, in places, limestone, and even sandstone, occurs. The latter beds are well developed in Alabama, where they are termed "Oxmore Sandstone." The shales, which are of a yellow or black color, are often quite calcareous; and, in places, they become very fossiliferous. The calcareous type, of this shale, is well developed in West Armuchee

¹ Geol. Surv. of Georgia, *The Paleozoic Group*, by J. W. Spencer, p. 212.

² *Ibid.*, p. 52.

valley, in the vicinity of Green Bush, where it is associated with thin beds of limestone. Both the shale and the limestone in that district are often highly fossiliferous, the most abundant remains being blastoids and bryozoa. The former fossils are usually siliceous, and, at some points, they are found in considerable abundance in the residual clay; while the latter are of a more calcareous nature, and occur as delicate markings embedded in the partially weathered shale. In addition to these fossils, corals and bivalves are also quite plentiful; and occasionally they are well preserved. The district, here referred to, is probably the best locality to be found anywhere in the State for the collection of fossils from the Floyd Shale horizon.

The black shale of the formation differs from the above shale, not only in color, but also in the lack of fossils and calcareous material. The black shale is highly carboniferous, and it is often difficult to distinguish it from the Devonian black shale, which it frequently closely resembles. At some points, as in the vicinity of Sugar valley, this black shale has been taken as an indication of coal, and has been prospected at considerable expense by drilling. Hayes, in speaking of the sandstone of the Floyd Shale, says:—"East of Taylor's Ridge, there is a thin-bedded, more compact sandstone, sometimes highly fossiliferous, which passes gradually into the Floyd shales above and below." In Texas valley, this sandstone gives rise to two ridges running parallel with the Fort Payne chert ridges.

The one mineral, of economic interest, associated with the Floyd shale, is the brown-iron ore. This ore, which has been somewhat extensively worked on the east side of Horn mountain, a short distance west of Sugar valley, occurs near the base of the formation; and, in places, it probably belongs to the Fort Payne chert. Brown-iron-ore deposits, similar to the above, are also to

¹ *Geology of North-East Alabama and Adjacent Portions of Tennessee and Georgia*, p. 47.

be seen in Redwine Cove, about three miles northwest of Carbon-dale.

THE BANGOR LIMESTONE.—The Bangor Limestone, in the absence of the Floyd shale, lies immediately above the Fort Payne chert. The formation corresponds to Safford's Mountain Limestone of Tennessee, and to Smith's Upper Sub-Carboniferous division of Alabama. The Bangor Limestone consists of blue and gray, heavy-bedded limestones, with a few thin beds of shale. The shales, which are usually of a green or red color, occur chiefly near the top of the formation, where they seem to mark a transitional stage between the calcareous deposits below and the argillaceous deposits above. Some of the layers of limestone occasionally contain a small amount of siliceous material, in the form of cherty nodules; though, as a general rule, the beds consist almost entirely of pure limestone.

The formation is quite fossiliferous throughout; but the organic remains are most abundant in the upper beds, which are made up mainly of clayey limestones. An excellent place, for collecting specimens of fossils from these limestones, is at the old lime quarry in Nickajack gulch, a short distance below the coke ovens at Cole City. The most abundant fossils of the Bangor limestone are blastoids, bryozoa and coals. Perfectly preserved blastoids, more than 1 1-2 inches in length, were picked up at the above named quarry. Cup corals, and a number of species of bivalves, all well preserved, are also to be found at this point, associated with which are innumerable fragments of *Archimedes*, a spiral-shaped coral, formed by *bryozoa*.

The thickness of the Bangor limestone in North Georgia, varies from 500 to 700 feet. It reaches its greatest development at the Georgia-Tennessee State-line, near Chattanooga, from which point it gradually decreases in thickness to the south and east. In the head of Johnson Crook, three miles east of Rising Fawn, accord-



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ing to my own measurements, the formation attains a thickness of 525 feet; while, just across the State-line at this point, in Deer Head Cove, Alabama, McCalley places the thickness at 400 feet.

The great difficulty, in estimating accurately the thickness of the Bangor limestone, lies mainly in defining its upper and lower limits. Below, it passes by a gradual increase of siliceous materials into the Fort Payne chert; while above, its change into the overlying calcareous shales, in places, is equally gradual. There is rarely ever any well defined line either above or below, that can be taken as marking the upper and the lower limits of the formation; and, as a result, different observers will naturally assign to the formation different thicknesses. Should all the limestone, lying between the lowest coal seam and the Fort Payne chert, be included in the Bangor Limestone, the formation in the vicinity of Cole City would attain a thickness of more than 900 feet;¹ but, on the other hand, if it were limited to the first heavy beds of shale, it would be reduced to less than 600 feet. Spencer's estimate of the thickness, which he places at 900 feet,² can be accounted for, only by assuming that his measurements were made from the uppermost layer of limestone in the shales near the first coal seam.

Lithologically considered, the upper beds of the Bangor Limestone may be said to be limited by the first thick beds of shale overlying the blue limestones. These beds, above which only thin layers of limestone occur, vary from 125 to 300 feet beneath the lowest coal seam.

The distribution of the Bangor limestone, like the Fort Payne chert, occurs in narrow strips along the flanks of Sand, Lookout and Pigeon mountains. It is also found in small detached areas in White Oak mountain, which is the northern extension of Tay-

¹ See Ferndale section.

² Geol. Surv. of Georgia, *The Paleozoic Group*, by J. W. Spencer, p. 52.

lor's ridge, and in Rocky and Little Sand mountains, east of Taylor's ridge. The formation at no place, with the exception of the exposure at the north point of Pigeon mountain, exceeds a mile in breadth. The extreme narrowness of the outcropping of the Bangor limestone is due to the formation being protected above by heavy beds of sandstone and conglomerate, which weather extremely slowly. In a few instances, the formation forms narrow, fertile valleys, between the base of the mountains and the Fort Payne chert ridges; but, generally, it is confined to the steep slopes of the mountains themselves, where it gives rise to deep, rich soils, often covered with a heavy growth of red cedar.

At some points on the mountain slope, owing to the thick mantle of talus derived from the sandstones and shales above, but little or no exposure of the Bangor limestone is to be seen; while, at other points, where the talus is wanting, it is very abundant, and occasionally forms bluffs several feet in height. Along these bluffs, and about the large exposures, are frequently to be found springs flowing from subterranean caverns. These caverns are quite common along the slopes of both Sand and Lookout mountains; and, in a few instances, they are reported to have been explored for long distances. The entrance to one of these caves, which has attracted some local interest, may be seen on the roadside at the foot of Sand mountain, about 1 1-2 miles southwest of Trenton.

The economic value of the Bangor limestone may be said to be confined chiefly to its purer beds of limestone, which are well suited for building and fluxing purposes, as well as for the manufacture of quick-lime. Excellent building-stones, of almost any dimension, can be obtained from these beds at numerous points along the slopes of either Sand or Lookout mountains. The stone is partially crystalline, and is generally quite free from chert and other impurities. The large quarry at Nickajack gulch, from

which considerable quantities of stone were formerly quarried for furnace purposes, testifies to its value as a fluxing material.

The three Sub-Carboniferous formations, above described, include all the rocks in Georgia belonging to Prof. H. S. Williams's Mississippi series. Williams, in his discussion of this group of rocks, says:—¹ "This series may be defined stratigraphically as that series of rocks prevailinglly calcareous, which occupy the interval between the Devonian system and the Coal Measures, and is typically developed in the States forming the upper part of the valley of Missouri, Illinois and Iowa." This author thinks, that the division of these rocks into groups is worthy of attention. However, he expresses the opinion, that such divisions cannot be final until the faunas are more thoroughly studied.

THE LOOKOUT MOUNTAIN SANDSTONE.—The Lookout Mountain Sandstone, which corresponds to Safford's Lower Coal Measures, consists of sandstones, conglomerates and shales, coal, and a few thin layers of limestone. The formation varies in thickness in Northwest Georgia from 300 to 400 feet. Its upper limit is defined by a heavy bed of conglomerate often seen forming the uppermost cliffs along the margin of Sand and Lookout mountains. The upper beds of the Lookout formation are made up chiefly of sandstone, with thin beds of argillaceous shale, and from two to five coal seams. The sandstone, in places, is coarse-grained; and it occasionally passes into a conglomerate. It is often cross-bedded; and, at some points, it shows numerous impressions of fossil plants. The shales, associated with the sandstone of the upper beds of the Lookout Mountain formation, are of a dark, or almost black, color. Some of these argillaceous beds carry considerable iron carbonate in the form of nodular concretions. A good example of a bed of this character is to be seen in Johnson Crook, just beneath the lowest coal seam.

¹ Correlation Papers—Devonian and Carboniferous, Bul. No. 80, U. S. Geol. Surv., page 135.

The lower portion of the Lookout Mountain formation consists of red and gray shales, with a few thin beds of sandstone and limestone. The shales, forming the upper part of the lower division of the Lookout formation, are usually quite sandy; while those beds occurring at a lower horizon are distinctly argillaceous. Associated with the latter shales, are a few thin beds of limestone. These calcareous beds increase in number, as the Bangor Limestone is approached. At some points along the western slope of Lookout mountain, the sandy shales above referred to, contain numerous fossils, the most abundant being bryozoa and fragments of crinoid stems.

The Lookout Mountain Sandstone, in Northwest Georgia, forms the surface rock along the margin and the upper slopes of Sand and Pigeon mountains. It caps Rocky and Little Sand mountain east of Taylor's ridge, and occurs in a small isolated area northeast of Ringgold, near the Georgia-Tennessee State-line. The total exposed area of the Lookout Mountain formation in Northwest Georgia is estimated to be about 30 square miles.

THE WALDEN SANDSTONE.—The Walden Sandstone, so called from Walden's ridge, Tennessee, where the formation is typically developed, lies immediately above the Lookout Mountain Sandstone, and forms the cap rock of Sand, Lookout and Pigeon mountains. It covers a total area in Northwest Georgia, of about 170 square miles, and is confined entirely to the top of the above mountains. The formation, which is made up of sandstone, conglomerate and shale, with from two to seven seams of coal, attains its greatest thickness at Round mountain in the vicinity of the Durham coal mines. Its approximate thickness at that point has been placed by Hayes at 930 feet.¹

The sandstones and conglomerates of the Walden formation

¹ Geologic Atlas, Ringgold Folio, U. S. Geol. Surv.

differ but little from the sandstones and conglomerates of the underlying formation. The shales are also quite similar; but, as a general rule, the Walden shales are more micaceous and sandy; and, at the same time, they are more fossiliferous; especially is this true of the shales associated with the coals.

CHAPTER II

TOPOGRAPHY

The topography of the coal-fields of Northwest Georgia is typical of the Cumberland Plateau region of Alabama and Tennessee. The most distinguishing physiographic feature of the area is the broad, more or less flat-top mountains, with their precipitous marginal cliffs rising from 800 to 900 feet above the valleys. Two of these mountains, namely Sand, or Raccoon, and Lookout, traverse the extreme northwestern corner of the State.

Sand Mountain, which is the southern extension of Walden's ridge, lies the furthest to the west, and is separated from Lookout mountain by Lookout valley. This mountain in Georgia has a maximum width of about six miles. Its surface, along the Georgia-Alabama State-line, is comparatively level; but, to the northeast, it becomes broken, and is deeply indented by Nickajack and Richmond gulches, the former on the west, and the latter on the east side of the mountain. North of these gulches, Sand mountain loses, in a great measure, its plateau character, and consists of irregular ridges and hills extending to the Georgia-Tennessee State-line.

The eastern brow of Sand mountain, which has a northeast-southwest trend, consists of a line of sandstone bluffs forming the western boundary of Lookout valley. These bluffs are generally two in number, one rising above the other. They vary in height from 30 to 80 feet; and, when viewed from the valley below, they have the appearance of a huge wall, with now and then a gap or break, through which the summit of the mountain can be gained.

Below the sandstone cliffs, the slopes of the mountain become more gradual, though even here, in places, the slope often becomes quite precipitous.

The western side of Sand mountain, which lies beyond the Georgia-Alabama State-line, differs from the east side mainly in having a more irregular boundary, due to the presence of large gulches, that have cut their way far back toward the center of the mountain. One of the largest and most noted of these gulches, is Nickajack, a narrow cañon-like gorge extending from the Georgia-Tennessee State-line, near Shellmound, to the southeast, some distance beyond the main axis of the mountain. The total length of this gorge, which, in places, is contracted to a width of less than 100 yards, is about 4 1-2 miles; while its depth varies from 600 to 700 feet. The scenery of this gorge is wild and picturesque. Especially is this true, near its head in the vicinity of Cole City, where it becomes much contracted, and is walled in on both sides by high sandstone cliffs extending up to the top of the mountain.

In passing northward from the above point, in the direction of Shellmound, the continuity of the sandstone bluffs are interrupted by the entrance of minor gorges from the right and the left. These minor gulches usually extend back from the main gulch only a short distance, where they terminate abruptly in one or more high sandstone cliffs, which often mark the place of small waterfalls. The diversity and the beauty of the scenery, which would otherwise be somewhat monotonous, is due, in a great measure, to these minor gulches.

Lookout mountain differs from Sand mountain chiefly in being much narrower, and in rising to a somewhat greater elevation. It may be defined as a long, narrow, comparatively flat-top, synclinal mountain with steep slopes, deeply indented by a number of prominent gorges. The mountain, which varies from one to five miles in width, has a northeast-southwest trend, and an average

elevation of about 1,000 feet above Lookout and Chattanooga valleys. At a few points, its summit reaches a height of more than 1,200 feet above the valley; but such elevations are always confined to small areas, or isolated peaks.

Near the Georgia-Alabama State-line, Lookout sends off to the northwest a very prominent spur, known as Pigeon mountain. This mountain, which is separated from the main mountain by McLamore's Cove, the southern extension of Chattanooga valley, has a length of about ten miles. Pigeon mountain, like Lookout, has a comparatively flat top and steep sides. It varies from 600 to 1,000 feet in height, and from an eighth of a mile to three miles in width. Its eastern side is indented by several deep gulches, which have been formed by small streams flowing from its summit.

North of the above spur, or subordinate mountain, the eastern brow of Lookout continues to the Georgia-Tennessee State-line, a distance of nearly 30 miles, with only a few breaks in the wall-like sandstone bluffs, which form its summit. Along this nearly straight stretch of sandstone bluffs, are to be seen a few isolated peaks rising from 200 to 300 feet above the general level of the mountain. The most prominent of these are High Point and Round Top, the former north, and the latter south, of a break in the bluffs, known as Moore Gap. Round Top, as the name suggests, is nearly circular; and, owing to its isolation, it forms one of the most conspicuous prominences to be seen at any point along the east brow of the mountain.

High Point differs from Round Top in being much elongated, and in having steeper slopes. The summit of the former peak, which is the highest point on Lookout, attains an elevation of 2,392 feet above sea-level. Its eastern side is a sheer precipice of sandstone cliffs, continuous with the bluffs, forming the brow of the mountain to the north and the south. The top of the peak, in places, is very rugged, being covered by immense sandstone



VIEW OF MCCALLIE GUICH, LULA LAKE, WALKER COUNTY, GEORGIA.



bowlders, the remnants of a once continuous stratum, formerly capping the top of Lookout.

A few miles north of High Point, occurs another prominence on the eastern brow, known as Eagle Cliff. This elevation, though not so high as the two eminences further to the south, is quite conspicuous when viewed from the valley below, on account of its high, bold, sandstone bluffs, which seem to stand out from the main mountain. These bluffs, forming Eagle Cliff, continue to the north for about two miles, where they are terminated abruptly by the deep gulch formed by Rock creek, a stream of considerable size, having its source on Lookout mountain, some miles to the south.

Rock Creek gulch, which is also known as McCallie gap, is on the eastern brow of Lookout. It presents the wildest and the most picturesque scenery, anywhere to be seen on the east brow of Lookout. The gulch, at its mouth, is a deep chasm, several hundred feet in depth, walled in on both sides by huge cliffs of massive sandstone. The sandstone cliff to the south, formed by the northern extension of Eagle cliff, is much broken, and the rocks along its summit, in places, stand out as bold, isolated pinnacles. In contrast with this, the north side of the gulch is formed by an unbroken wall of sandstone continuous with the long line of sandstone bluffs to the north. Within this gulch, where these two lines of sandstone cliffs unite, is located Lula falls, and just beyond, Lula lake. The falls, which reach their descent in a single plunge, have a height of about 60 feet. The lake is a large, deep, circular pool, or pot hole, 75 feet or more in diameter, scooped out of the hard sandstone rock. Its quiet and placid waters present a marked contrast with the roaring waters of the falls below. Beyond the lake, the sandstone cliffs give way to steep slopes, where Rock creek runs in a narrow V-shaped gorge, which extends southward to the Durham coal mines, a distance of about 7 miles. North

of McCallie gap, the sandstone cliffs continue to the Georgia-Tennessee State-line with but few breaks.

The west side of Lookout has generally a more precipitous slope and higher bluffs than the east side. Especially is this true of the northern part of the mountain, in the vicinity of the Georgia-Tennessee State-line. The sandstone bluffs are also more continuous, and not so often interrupted by deep gulches. From the Georgia-Tennessee State-line, on the east side of the mountain to Trenton or Sitton gulf, a distance of more than 12 miles, there is scarcely a break in the bluffs; and, at only two or three points, are there trails leading from the top of the mountain to Lookout valley below. The sandstone bluffs are unusually bold, and the slopes of the mountain below are, at the same time, steep.

: Trenton gulf above referred to, is a deep cañon, formed by Bear creek, which takes its rise near the eastern brow of the mountain. The main part of the gulf, which varies from 600 to 800 feet in depth, is about two miles in length. Its walls are steep; and, in places, they are formed of sandstone cliffs, 200 or 300 feet in height. A view of the gulf from the summit of these cliffs is excellent; and it reminds one very much of a view of Tallulah gorge in Rabun county.

To the south of Trenton gulf, is another gulf of much larger size known as Johnson crook. This gulf, which is really the northern extension of Wills' valley, Alabama, cuts a deep, broad gash into the western side of Lookout. It is surrounded on all sides, except to the south, by a long line of sandstone cliffs, which mark the western brow of the mountain. South of Johnson crook, are Forester's and Tatum's gulches, both breaking the continuity of the sandstone bluffs, which continue in an almost straight course to the Georgia-Alabama State-line.

The surface of Lookout mountain, though generally spoken of as being level, becomes, in places, irregular and somewhat broken.

Especially is this true, in the neighborhood of the streams. The brow of the mountain, at most points, has a slightly greater elevation than its center, which thereby gives to the mountain the form of a shallow trough. The peculiar topographic features of the mountain become most striking, when viewed from the high points on the east and west brows. The streams of the mountain, on account of its trough-like form, are confined largely to the main axis of the mountain ; and they are enabled to reach the valley below, only by cutting deep channels through the elevated brow. At one point on the mountain, near the sources of Rock and Bear creeks, where denudation seems to have acted very slowly, is a lonely, isolated elevation, 300 feet in height, known as Round mountain. The top of this mountain rises to a somewhat greater elevation than the brow to the west; but, on the east brow, High Point and Round Point attain a somewhat greater height ; so that, even at this point, the mountain may be said to still retain its trough-like form.

CHAPTER III

STRUCTURAL GEOLOGY OF THE COAL FIELDS

The structural geology of the coal fields of Georgia is quite simple. The Carboniferous and the underlying strata, which were formerly laid down as horizontal beds of sand, clay etc. on the sea bottom, have been changed by lateral pressure into a number of huge anticlinal and synclinal folds, having a northwest-southeast trend. One of the most prominent of these folds, is the Lookout syncline, forming Lookout mountain. This fold, which has its northern terminus in Tennessee, traverses the northeastern corner of Georgia, and continues southward into Alabama. The width of the fold, as measured by the limits of Lookout mountain, varies from one to five miles. Its greatest width is just south of McLamore's cove, near the Georgia-Alabama State-line, from which point it gradually decreases in width to the north. With a few local exceptions, the fold is quite symmetrical; that is, the strata from both sides of the mountain dip at about the same angle towards the axis of the fold.

At the head of McLamore's cove, the Lookout syncline sends off to the northeast a small secondary syncline, forming Pigeon mountain. These folds are separated from each other by the Chattanooga anticline, which terminates in the head of McLamore's cove, and extends northeast, along the east side of the mountain, to Chattanooga. East of the Pigeon Mountain syncline, and forming the eastern boundary of the southern extension of the Lookout syncline, is the Chattanooga anticline, which extends for many miles to the northeast.

West of Lookout mountain, the structure here described is again repeated. To the extreme northwest, is the broad syncline of Sand mountain, followed by the Lookout Valley syncline, which stops short in Deerhead cove, thus separating from the main syncline, the Fox Mountain syncline, a counterpart of Pigeon mountain, which, in turn, is limited on the east by the Wills' Valley anticline. The structural geology of the coal fields, here outlined, will be readily understood by an examination of Hayes's outline map of this region.¹

MINOR STRUCTURAL FEATURES AS SHOWN IN THE WORKING OF THE INDIVIDUAL COAL SEAMS

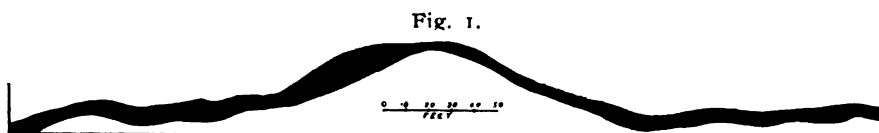
In addition to the large structural features, above referred to, there are minor structural features, which have a very important bearing on the commercial value of the coal seams. These minor features, which are more or less common in all coal fields, may be grouped for convenience of description under the headings, *folds*, *faults*, and *irregularities in the thickness of beds*. The first two divisions, here mentioned, are due to movements in the earth's crust, subsequent to the formation of coal; while the other may be due to the same cause, or to the irregular deposition of the coal itself.

In the formation of the huge anticlinal and synclinal folds, heretofore described, there were produced, at the same time, an indefinite number of small folds. These minor folds, which often seriously interfere with mining, are quite irregular in their distribution. At some points, they are entirely absent, and the strata extend for long distances practically level; while, at other points, they are more or less abundant, and the strata appear in wave-like undulations. The width of the individual folds, like their height, is quite variable. In some instances, they may measure 100 feet,

¹ See Bull. No. 4, Ala. Geol. Survey.

or more, from crest to trough; but, as a general rule, the width is limited to a few rods.

These minor folds interfere with mining in two ways. In the first place, they interfere with the drainage of the mines; and, in the second place, they often affect the uniformity of the coal seam itself. It will at once be understood, in what manner the folds hinder drainage, when it is stated, that the floor of the mines, where the folds occur, is always undulating and otherwise more or less irregular. In such cases, the only way to make the mines self-draining is to connect the troughs of the several folds by tunnels or cross-cuts.¹



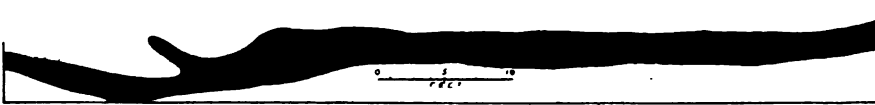
Section Showing Undulations in Coal Seam. Also, the Thickening and Thinning of the Seam Itself.

The effect of the folds on the uniformity of the coal seam itself is also well illustrated by the same figure. The thickness of the coal seam on the side, or near the center of the trough of the fold, as here represented, is generally greater than it is at the crest. This irregularity in thickness seems to be largely due to the flowing or movement of the coal, under great pressure, from the crest to the trough of the fold, subsequent to its deposition, and at the time the mountains themselves were being formed. At some points, the coal seam at the crest of the fold is said to be reduced in thickness to a few inches, called a "squeeze"; but, in such cases, the seam in the adjoining trough is generally correspondingly thickened. These "squeezes," as is shown on the map of the Slope and the Rattlesnake mines, always have their longer axis running northeast and southwest. A good example of the enlargement of

¹ See fig. 1.

the coal seam in the trough of a fold is said to occur in the Elijah mine at Cole City, where the Dade coal seam at one point attains a maximum thickness of 17 feet. Besides the thickening and the thinning of the coal seams, here described, sharp or abrupt folds sometimes gives rise to another structure shown by Fig. 2. In this case, the overlying shale at one point has been broken, and the coal has apparently flowed, or been forced up, into the fissured sandstone above.

Fig. 2.



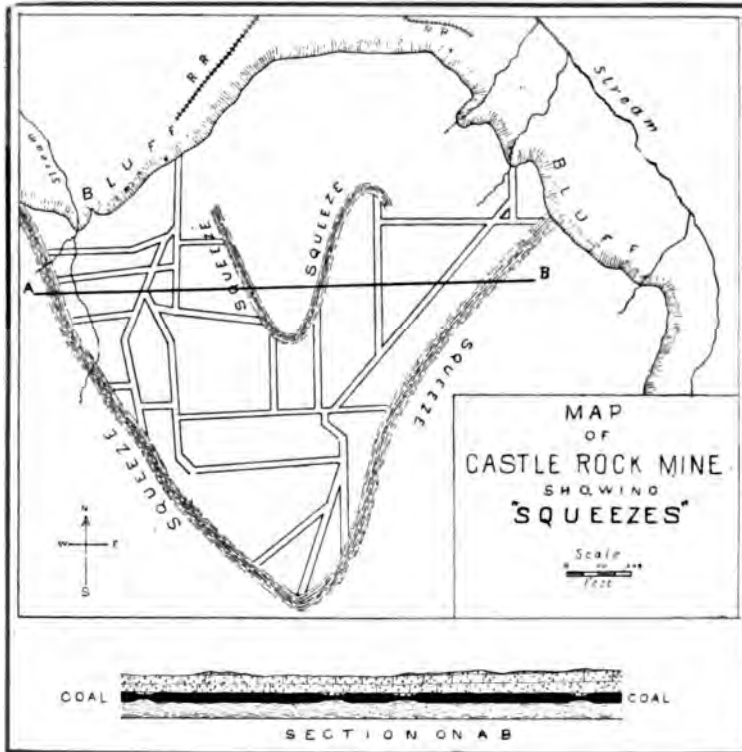
Vertical Section Showing Irregularity in Coal Seam.

Small faults, of a few feet throw, are reported to occur in the different mines in the vicinity of Cole City; but none of them were examined by the writer. Displacements of this character, however, were noticed along the narrow-gauge road between Cole City and the coke ovens. The best exposure of these faults is to be seen along the sandstone bluff, just north of the coal chute, which extends from the top of the mountain to the coal-washer in the gulch. In no case, do these faults represent a displacement of more than a few feet.

The thinning and thickening of coal seams, due to irregularity in deposition, is well illustrated by the Castle Rock seam in the Cole City district.¹ This seam, at the old Castle Rock mines near the Georgia-Alabama State-line, where it was worked for several years, attains a thickness varying from three to four feet; but, to the east of these mines, the seam decreases in thickness, so that, in the vicinity of Cole City, it is reduced to a few inches, or is entirely wanting. Similar variations in thickness, which can be

¹ See fig. 3.

Fig. 3.



accounted for only by irregularity in deposition, are also met with, in the Dade and Rattlesnake seams of the same district. Dr. J. W. Spencer, in speaking of these variations, says:¹ "Whilst the Coal Measures occupy a long, synclinal trough, yet the individual beds are separated into basins of various extent, and represent the individual marshes of the Carboniferous period, when the region was occupied by extensive swamps more or less separated by such hammocks as rise in the extensive swamps of Florida to-day. These changes in the surface features gave rise to thinning and thickening of the coal beds. Yet many of the deposits, although separate, had doubtless a synchronous origin." Major

¹ Geol. Surv. of Georgia, *The Paleozoic Group*, p. 253.

M. T. Singleton, Mining Engineer of the Georgia Iron & Coal Company, who has made an extensive study of the coal deposits of Sand mountain, expresses similar opinions to the above, in regard to the variation of the coal seams in the Cole City district.

CHAPTER IV

THE COAL DEPOSITS OF WALKER COUNTY

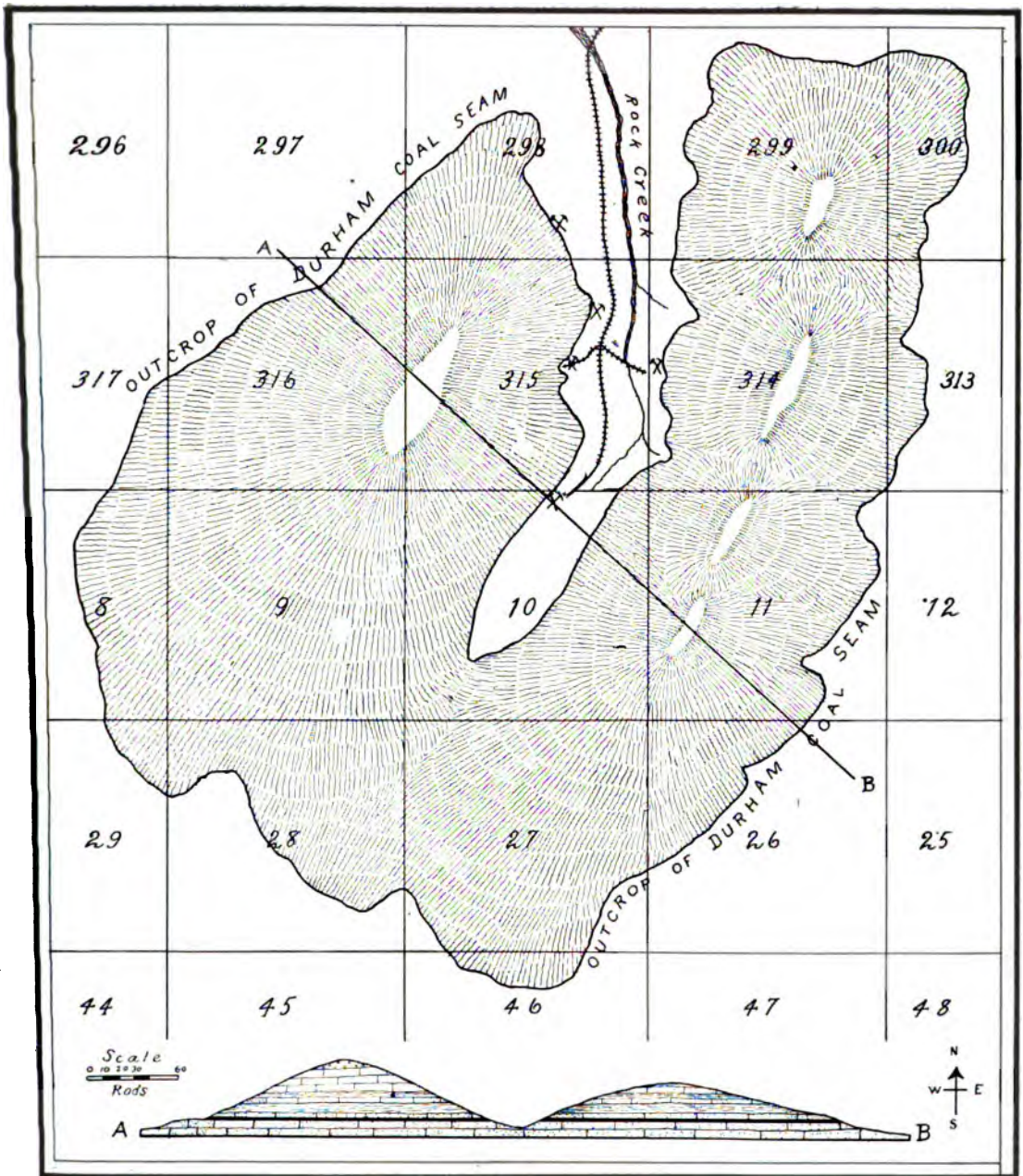
The coal deposits of Walker county are confined to Pigeon mountain and the eastern side of Lookout mountain. The most valuable coal seams are those of the Upper Coal Measures on Lookout, in the vicinity of the Durham mines described below. In addition to these coal seams, there are others, of considerable promise, in the Lower Coal Measures. The latter, however, have been prospected only to a limited extent, and their commercial importance is in a great measure unknown.

THE DURHAM COAL MINES

The Durham coal mines, now operated by the Durham Coal and Coke Co., of Chattanooga, are located on Lookout mountain about 12 miles southeast of Chattanooga. The outcropping of the coal occurs here at the base of Round mountain, a small elevation having a maximum height of 300 feet above the general level of Lookout.

Round mountain, as the name suggests, is nearly circular; although it is deeply indented on its north side by a gorge, formed by the head-waters of Rock creek.¹ Taking the outcropping of the Durham coal seam as its base, the mountain measures nearly five miles in circumference. It is situated about equi-distant from the east and west brows of Lookout, which are here more than five miles apart. The ascent of Round mountain from the south and west, is generally gradual; while, to the north and east, it

¹ See Map.



Map of Round Mountain, Walker County, Georgia.

becomes more precipitous. The surface of the mountain is by no means uniform. On the contrary, it is often furrowed by numerous small hollows, eroded mainly by the action of rain-waters, as they descended its slopes. Capping the highest point of the mountain, which lies only a short distance west of the present entrance to the coal mines, is to be seen a heavy bed of coarse-grained sandstone, or conglomerate, having a total thickness of something like 40 feet. The conglomerate, in weathering, has left on the surface, in places, huge, rounded boulders, not unlike the erratic boulders of the glaciated regions.

The view from the above point is excellent. To the west, some two miles away, is to be seen the western brow of Lookout, which seems to rise several feet above the intervening stretch of country. To the east, a similar view presents itself; though the elevation of the brow here seems to be more pronounced. Two of its highest peaks, namely, High Point and Round Top, are especially prominent, and rise from 150 to 200 feet above the point of view. Such a view clearly shows that Lookout mountain is here in the form of a shallow trough, with Round Top mountain near its center. The origin of this somewhat peculiar land-form has its explanation in the structural geology of Lookout mountain, which has been discussed under a separate head.

A workable coal seam has long been known to outcrop at the base of Round mountain. At two or more points, it is said to have been worked, to a limited extent, prior to the Civil War, when the commercial value of the coal was fully demonstrated by its use in the blacksmith forge. The old excavations at the base of the mountain on the south side, now known as Green's bank, are pointed out as the remains of one of these early workings. Much of the coal used 20 years ago in the blacksmith-shops, both on Lookout mountain and in the adjacent valleys, was obtained from Round mountain.

Active mining operations might be said to have begun at Round mountain in 1891, a few months previous to the completion of the Chickamauga and Durham railroad to that point. The first shipments were made in 1892, since which date the mines have been in continuous operation. At the time of the writer's visit to Round mountain, the mines gave employment to 150 convicts and a limited number of free laborers. The daily output of the mines at that time was 700 tons.¹ Something like one-fifth of the total amount of coal, then produced, was manufactured into coke, and the remainder was used for steam and other purposes.

The Durham mines are well equipped with all the necessary machinery, needed to carry on successful and economic mining. The plant consists of a coal-washer, with a capacity of 300 tons per day; 150 coke ovens, 100 of which are located at Chickamauga; small locomotives, with which to handle the coal, both in the yard and within the mines; machine and blacksmith shops; a commissary and an office building; residences for the superintendent and the physician; and numerous miners' cottages and convict barracks. The plant is located in the gorge at the entrance to the mines on the north side of the mountain. The location has been well selected; and, as a consequence, the entire coal seam can be worked without any special inconvenience from long underground hauls. Furthermore, the plant is located at a point, toward which the coal seam dips from all directions. This insures the least possible expense in delivering the coal to the tipple, and also in draining the mine. If the coal seam lay in a uniform plane, that is, not subject to undulations, the mine would not only be self-draining, but the coal could also be delivered at the washer by gravity.

There are four entrances to the mines, three on the west side of the gorge, and one on the east. The main part of the workings,

¹ The output of the mines is at present about 1,000 tons per day.

which includes an area of more than 200 acres, lies on the west side of the gorge beneath the highest point of Round mountain. At several places, on the opposite side of the mountain, where the ventilating shafts are located, the works extend to the surface. With the exception of about 50 acres on lot 298, owned now by the Lookout Coal & Coke Co., much of that part of the coal seam, lying directly west of the gorge, has been worked out. The workings east of the gorge are not extensive. The entire area, from which the coal has been taken, would probably not exceed 20 acres.

The amount of workable coal, still remaining in the Durham seam, probably does not fall far short of 1,000 acres. This estimate is not a mere matter of conjecture; it is based upon the natural and the artificial exposures of the vein, which encircle the entire base of the mountain. The amount of coal, here practically in sight, is sufficient to keep the mines running for several years, at their present rate of output.

The Durham coal seam, in places, attains a thickness of 7 feet; but its average thickness is not over 38 inches. The seam is divided near the center by a parting of slate, varying in thickness from a few inches to two feet. There appears to be little or no difference in the character of the coal above and below the slate, both divisions being made up of bright, clear coal, having a slight columnar structure when undisturbed. The seam, as previously stated, has a general dip toward the gorge or the center of the mountain, and it, therefore, lies in the form of a basin. The points, at which the greatest elevations of the outcroppings of the seam occurs, are on the east and the west sides of the mountain nearly directly opposite each other. These points have an elevation of about 100 feet above the lowest outcrop of the coal in the gorge at the entrance to the mines.

The chemical composition of the Durham coal is shown by the

following analysis by Dr. Gustave Biddel, formerly of Chattanooga, Tenn. : —¹

Fixed Carbon	79.100
Volatile Matter	16.030
Ash	4.810
Sulphur	0.360
Phosphorus	0.007
Total	<u>100.307</u>

Another analysis, made for Mr. A. S. Hewitt, of New York, gives the following results : —²

Fixed Carbon	75.956
Volatile Matter	21.011
Moisture	0.615
Ash (Salmon color)	1.940
Sulphur047
Total	<u>99.569</u>

The above analyses show that the Durham coal is excellent for coking purposes. Its fixed carbon runs higher than the Pocahontas coal, and the amount of ash and sulphur present is unusually low. The coke manufactured from the Durham coal is hard, strong and highly cellular. Col. Gaines, General Manager of the Tennessee Coal & Iron Co.'s furnaces, at South Pittsburg, in speaking of this coke, says : "The coke made from the Durham coal is of an excellent quality. I consider it equal to any coke manufactured in the south for furnace purposes."

The analysis of the coke made for Mr. A. S. Hewitt, of New York, is as follows : —

Fixed Carbon	90.31
Volatile Matter	1.20
Ash	8.53
Sulphur	0.53
Total	<u>100.57</u>

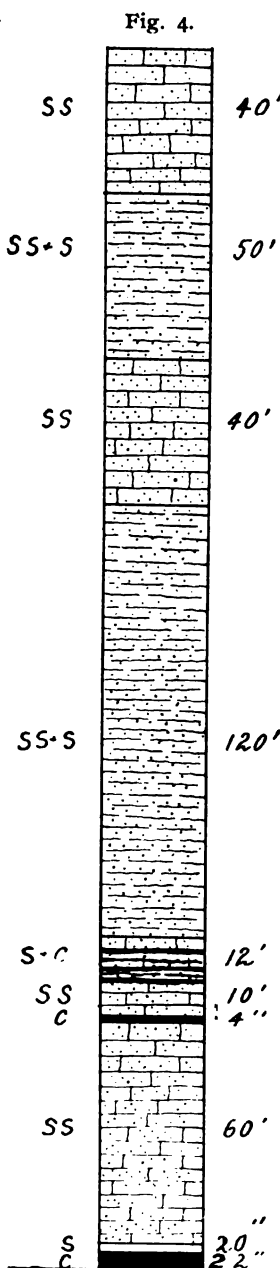
¹ Geol. Surv. of Georgia, *The Paleozoic Group*, by J. W. Spencer, p. 258.

² *Ibid.*, p. 259.

There are two other coal seams on Round mountain, outcropping at a higher elevation than the Durham seam. Both of these veins, as shown by the section below, are small veins, and, as a consequence, have no commercial value. The section here given includes the several beds of rock in the descending order, together with coal lying above, and including, the Durham seam : —

Coarse-grained, heavy-bedded Sandstone.....	40 feet
Sandy Shale (partly concealed).....	50 "
Sandstone.....	40 "
Shaly Sandstone (partly concealed).....	120 "
Black Shale with thin partings of Coal.....	12 "
Sandstone.....	10 "
Coal.....	4 inches
Sandstone (cross-bedded)...	60 feet
Shale.....	20 inches
Coal.....	22 "
Shale.....	8 "
Coal.....	20 "
Fire-clay.....	2 feet

The geological section, here given, is on the west side of the gorge extending from the entrance to the mines to the highest point on the mountain. On the opposite side of the gorge, and about half-a-mile south of the convict barracks, near the public road leading to Cooper gap, are other exposures of these Upper Coal seams. The lower of the two is here



represented on the roadside by a streak of smut in the disintegrated sandstone overlying the Durham seam; while the other appears as thin partings in a bed of black shale. At the top of the black shale, near its contact with the overlying sandstone, the coal becomes more abundant; and, at one or two points, in some washes in an old, abandoned field, is to be seen along the hillslopes another exposure of coal, varying from 12 to 18 inches in thickness. The coal here exposed has a columnar structure and is apparently of fair quality, although the thinness of the seam renders it practically of little or no commercial value.

THE LOOKOUT COAL AND COKE COMPANY'S PROPERTY

This coal property, as is above stated, is located on *lot 298, 10th district*, and embraces the northern extension of the Durham coal seam. By an examination of the map of Round mountain, it will be noticed, that the Durham coal underlies only about a third of the lot, or something like 50 acres. This property, which was formerly owned by Mr. E. W. Marsh, of Atlanta, was purchased by the above named company in the summer of 1900. Shortly after the property changed hands, the mine was opened; and it has been in continuous operation ever since. The company now employs about 50 convicts, and also a limited number of free laborers. The output of the mine at present is 200 tons of coal per day, which is used chiefly for steam and smithing purposes.

EXPOSURE OF COAL IN ROCK CREEK GULCH BETWEEN THE DURHAM MINES AND M'CALLIE GAP

The first exposure of coal in Rock Creek gulch, north of the Durham mines, is in a cut on the west side of the railroad, near the first mile-post. The exposure is located on *lot 278, 10th district*, which is owned by Mr. J. T. Buckhalter. The lot, however, at the time of our visit, was under a 60-day option to Dr. Robert



LOWER FALLS, LULA LAKE, ON THE DURHAM RAILROAD, WALKER COUNTY, GEORGIA,
SHOWING EXPOSURE OF THICK-BEDDED LOOKOUT SANDSTONE.

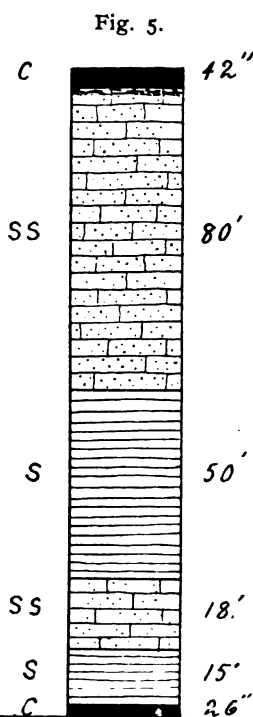


Tatum, who was then engaged in prospecting the coal seam.¹ This coal seam is undoubtedly the same seam, that is reported to have been penetrated at the Durham mines in a bore-hole, at the depth of about 150 feet from the surface. The exposure of the rock along the railroad in the gulch, between the outcropping of the Durham and the above coal seam, shows the following geological section in the descending order:—

1 Durham Seam	42 inches
2 Fire-clay	2 feet
3 Sandstone (cross-bedded)	80 "
4 Black and gray Shales	50 "
5 Massive Sandstone	18 "
6 Black Shale	15 "
7 Coal	26 inches

Below this coal seam, which we shall designate as the Tatum seam, is about two feet of indurated fire-clay, which in turn overlies thin-bedded, shaley sandstone. In the above section, between 10 and 17 feet above the Tatum coal seam, Dr. J. W. Spencer reports the occurrence of a bed of limestone.² It is presumed that this information was obtained from the boring at the mine; as no such formation was observed at the surface along the railroad.

The Tatum coal seam is exposed for 100 yards along the west side of the railroad, and also at one point in a small ravine on the east side. The most of the prospecting has been done at the latter place, where the seam has a maximum thickness of 26 inches. On the opposite



¹ Since the above was written, lot 278, 10th district, has been purchased by Mr. James W. English, Jr., of Atlanta.

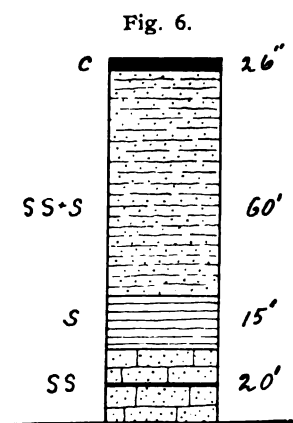
² Geol. Surv. of Georgia, *The Paleozoic Group*, by J. W. Spencer, p. 255.

side of the road, the seam was not faced up; but it appeared to retain pretty nearly the same thickness. The seam lies practically horizontal; and, as a consequence, it gradually rises above the road-bed, which here has a considerable down grade to the north.

The coal has a columnar structure, and is generally quite free from slate or other impurities, as is shown by the following analysis made for the Survey by the N. P. Pratt Laboratory, of Atlanta:—

Fixed Carbon.....	75.980
Volatile Matter.....	20.850
Moisture.....	1.020
Sulphur.....	0.760
Phosphorus.....	.007
Ash.....	1.440
Total.....	100.057

This coal has practically the same chemical composition as the Durham coal; and it may, therefore, be said to be well suited for both steam and coking purposes.



THE SECOND EXPOSURE OF COAL IN ROCK CREEK GULCH occurs in a railroad-cut near Mr. H. M. Miller's residence, about two miles north of the Durham mines. The exposure consists of a small seam of coal, not over two inches in thickness, in strata of thin-bedded sandstone. A geological section from this point to the outcropping of the Tatum seam, made out from the exposures along the railroad in the descending order is

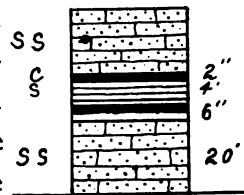
here given:—

1 Tatum Coal seam.....	26 inches
2 Fire-clay.....	2 feet
3 Thin-bedded, shaley Sandstone.....	60 " (?)
4 Black Shale.....	15 "
5 Sandstone with thin layer of Coal.....	20 "

THE THOMAS AND McCALLIE PROPERTY

About a quarter of a mile east of the above exposure, in a deep hollow, on *lot 265, 10th district*, owned by Messrs. Thomas & McCallie, of Chattanooga, is another exposure of coal, 300 feet below the Durham seam, measured with an aneroid barometer. The outcrop occurs on the side of a small stream, where, at one point, a short tunnel has been driven into the hillside. The excavation is now inaccessible. However, from the exposure along the branch and on the hillslope, the following section was made out:—

Fig. 7.



1	Sandy Shale.....	20 feet
2	Coal.....	2 inches
3	Black Shale.....	4 feet
4	Coal.....	6 inches
5	Black Shale with partings of Coal.....	3 feet
6	Sandstone (exposed).....	20 "

The black shale associated with the coal is quite fossiliferous. The impressions of fern leaves are particularly well preserved.

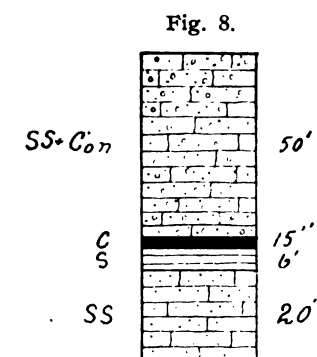
Near the center of the same lot, not far from the top of a ridge, is a second outcrop of coal. This coal seam has an altitude of about 150 feet above the seam exposed in the hollow, and it, therefore, corresponds in elevation to the Tatum seam. It is exposed at two points, only a few rods apart; one, a natural, and the other, an artificial, exposure. The artificial exposure is in a drift 10 feet long, at which point the section below was made out:—

1	Sandstone, cross-bedded, forming top of ridge...	30 feet
2	Coal, laminated and having columnar structure...	6 inches
3	Black Shale.....	4 " (?)
4	Coal smut.....	3 "
5	Fire-clay and Slate (exposed).....	12 feet (?)

This coal seam is supposed to be the same as the Tatum seam.

However, there is quite a marked difference in the character of the associated rocks, as is shown by the geological section given above.

On the opposite side of the railroad, and at about the same distance from Mr. Miller's residence, in the last named exposure, is another outcrop of the same coal seam. The outcrop here exposed is on the Griffy property, *lot 241, 10th district*, well up on the side of the ridge, 100 feet or more above the railroad. A few old excavations are to be seen here just below a sandstone bluff, 15 or 20 feet high, at which point a coal seam, only a few inches in thickness, was struck, a short distance beneath the surface.



A THIRD EXPOSURE OF COAL IN ROCK CREEK GULCH is to be seen in a cut on the Durham & Chickamauga Railroad near the 11-mile post. The coal seam, which has a thickness of about 15 inches, is exposed for 200 or 300 yards along the west side of the railroad; but it finally dips beneath the surface to reappear again, a short distance beyond.

The seam appears to vary but little in thickness throughout its entire exposure. The coal seems to be of fair quality; though its entire outcropping is generally much weathered. The following section is here made out from the exposure along the railroad:—

1 Sandstone and Conglomerate	50 feet
2 Coal	15 inches
3 Shale	6 feet
4 Sandstone (exposed)	20 "

It is a difficult matter to determine the exact distance this coal seam lies below the Tatum seam, on account of there being no continuous exposure along the railroad between the two outcroppings. Dr. J. W. Spencer places the distance between the

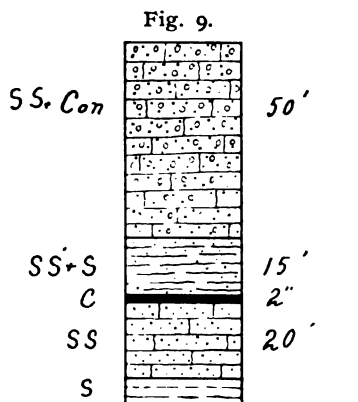
two seams at 150 feet.¹ This estimate may be approximately correct. However, the data at hand are so meagre, that even an approximate estimate seems to be, in a great measure, a mere matter of conjecture.

In the gulch between the 11-mile post and Lula Lake, are two or three traces of coal in the sandstone. There is also still another trace of coal in the railroad cut at Eagle Cliff just beyond Lula Lake.

The section along the railroad from Lula Lake to the high trestle on the south side of McCallie Gap is as follows : —

1	Massive Sandstone and Conglomerate (Eagle Cliff)	150 feet
2	Thin-bedded Sandstone	60 "
3	Sandy Shale	10 "
4	Black Shale	15 "
5	Sandy Shale	50 "
6	Gray Shale	50 "
7	Thin-bedded Sandstone	40 "

The section above given embraces all the Lower Coal Measures, with the exception of something like 150 feet of shales, here hidden by a mantle of talus derived from the cliff above. It will be seen, that there is no exposure of coal in the section here given; although, at points both north and south of this gap, coal is known to occur just below the massive sandstone and conglomerate, which form the brow of the mountain. This coal seam is fairly well exposed in the public road at Nickajack gap, only a short distance south of Eagle cliff, where it attains a thickness, as shown in the following section, of about two inches : —



¹ Geol. Surv. of Georgia, *The Paleozoic Group*, by J. W. Spencer, p. 139.

1 Sandstone and Conglomerate, forming the top of the mountain (exposed).....	50 feet
2 Shaley Sandstone	15 "
3 Coal smut.....	2 inches
4 Fire-clay.....	1½ feet
5 Sandstone.....	20 "
6 Shale	(?)

OTHER EXPOSURES OF COAL ON LOOKOUT, NORTH OF ROUND MOUNTAIN

There are a number of coal exposures on Lookout, north of Round Mountain, the most important of which are here described:—

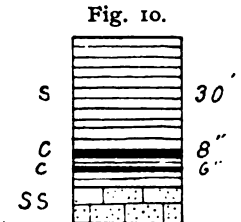
S. T. CARSON'S PROPERTY.—This property, *lot 240, 10th district*, is located on the east side of Rock creek about 1 1-2 miles northeast of Round mountain. There are two exposures of coal on this lot, one near its *southeast* corner and the other, near its center. The exposure near the southeast corner of the lot occurs in a drift 20 feet in length, located on a rather steep hillslope. The coal seam here exposed has a thickness of 18 inches, and lies about 120 feet below the Durham seam. The coal is columnar, quite iridescent, and free from impurities, as is shown by the following analysis, made by the N. P. Pratt Laboratory, of Atlanta, for the Geological Survey:—

Moisture60
Volatile and Combustible Matter	19.12
Fixed Carbon	76.98
Sulphur93
Ash.....	3.30
Total	<u>100.93</u>

The exposure, near the center of lot 240, is also an artificial exposure; but the coal belongs to another seam, lying 140 feet below the first seam, near the northeast corner of the cut. The workings at this point consist of an open-cut in the hollow, 10 or

15 feet long, and a shaft on the hillside, 20 feet or more in depth. The section, made out at this point, from the exposures along the hillslope, is as follows : —

1 Shale	30 feet
2 Coal	8 inches
3 Shale	4 "
4 Coal	6 "
5 Fire-clay	30 "
6 Sandstone	(?)



The following is an analysis of coal from the above exposure, made by the N. P. Pratt Laboratory for the Geological Survey : —

Moisture	.49
Volatile and Combustible Matter	20.35
Fixed Carbon	66.91
Sulphur	1.05
Ash	12.25
Total	101.05

THE BRYAN & SHAVER PROPERTY. — The exposure of coal on this property, *lot 165, 10th district*, is located three quarters of a mile west of Rock creek and about five miles north of the Durham mines. Coal is here to be seen in a recent drift, 100 feet long, located on a hillslope. The coal has a columnar structure, and appears to be of a good quality. The seam, however, at this point, as is shown in the following section, is not of sufficient thickness to be workable : —

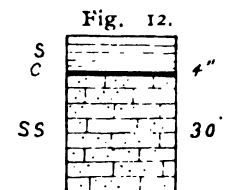


1 Shale	4 feet
2 Coal	5 inches
3 Shale	3 feet
4 Coal	8 inches
5 Fire-clay	(?)

This coal appears to correspond to the seam below the Tatum seam ; but the data at hand are not sufficient to determine its exact geological horizon.

MRS. M. M. THOMAS'S PROPERTY.— This prospect is located on *lot 19, 10th district*, near the west brow of Lookout mountain, about one mile south of the Georgia-Tennessee State-line. The exposure is to be seen in a small excavation near a chalybeate spring, which is located in a depression, some 30 feet or more below the top of the eastern brow of the mountain. The coal

seam, which has a thickness of only about four inches, dips to the east at a low angle. The position of the coal, together with its associated rock, as is shown by the section below, seems to indicate, that this coal belongs to the upper bluff seam, which occurs



at numerous points on the west brow of Lookout mountain, south of this point. The section above referred to is as follows: —

- | | | | |
|---|---------------------------|-------|----------|
| 1 | Black fossiliferous Shale | ----- | (?) |
| 2 | Coal | ----- | 4 inches |
| 3 | Sandstone | ----- | 30 feet |

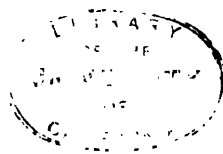
On an adjoining lot (*No. 54*), lying immediately south of the Thomas prospect, and now owned by Mrs. P. Carruth, is another coal outcrop, which appears to belong also to the second bluff seam. The coal on the Carruth property is exposed along a drift extending into the hillside for a distance of 90 feet. The coal here is much crushed, and the dip is to the west, at about one foot in thirty. The section, at this exposure, is very similar to the section at the Thomas prospect. However, shale occurs here immediately below the coal, where sandstone occurs in the Thomas section.

EXPOSURE OF COAL ALONG BEAR CREEK

There are a number of outcrops of coal along Bear creek, the most extensive of which is to be seen at what is known as the Allison bank, on *lot 64, 11th district*, about half-a-mile south of



CUT ALONG THE DURHAM RAILROAD, NEAR LULA LAKE, WALKER COUNTY, GEORGIA,
SHOWING AN EXPOSURE OF LOOKOUT SANDSTONE.



Round mountain. The exposure at this point is in a drift, 50 or 60 feet long, extending into the hillside. The excavation was made some years ago, and it is now partly filled with fallen earth. The coal exposed to view has a columnar structure, and appears to be of fair quality. From the exposures on the hillside and in the excavation, the following section was made:—

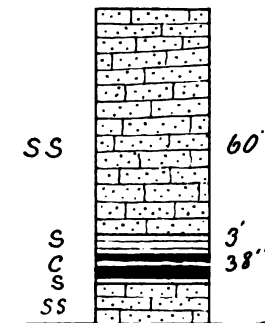
1 Sandstone	60 feet (?)
2 Shale	3 "
3 Coal	19 inches
4 Shale	4 "
5 Coal	19 "
6 Fire-clay	2 feet
7 Sandstone, thin bedded	(?)

This coal seam is supposed to be the same as the Tatum seam; and it, therefore, lies below the Durham seam. The main difficulty in correlating the two seams is their great difference in depth below the Durham seam. The Tatum seam, at its outcropping on the Durham & Chickamauga Railroad, and also in the bore-hole put down at the mines, is found to be about 150 feet below the Durham seam, whereas the above seam is only about 80 feet. This variation of depth below the Durham seam, can be accounted for only by assuming an unusual thickening of the intervening formations in passing toward the south.

Something like a mile north of the above exposure, on lot 45, owned by the Durham Coal Mining Co., is a second exposure, in a small open-cut. The coal seam here is only about 18 inches in thickness, and is divided, as at the other exposure, by a thin parting of shale.

Southwest of the Allison bank, about half-a-mile, is a third ex-

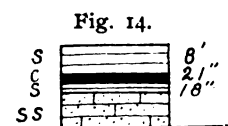
Fig. 13.



posure of the same seam. This exposure is on *lot 65*, which is owned by Mr. Walter Wood, of Philadelphia, Penn. The coal is to be seen in a recent excavation, well up on the hillside. It has a maximum thickness of 24 inches, and is not divided, as at the other points, by a parting of shale. The coal seam here is overlain by a heavy stratum of sandstone, which caps the top of the hill. On a lot lying directly *west of lot 65*, in Dade county, is still another exposure of coal, on what is probably the same seam as the above. The coal at this point is likewise exposed in a cut on the hillside. The seam, which is only about six inches in thickness, is underlain by a stratum of black shale having thin partings of coal. In Mann gulf, near the last named exposure, were seen two other excavations, in which small seams of coal are reported to have been struck. All the coal exposed at the above named points is thought to belong to one and the same seam, viz., the Tatum seam.

C. E. JAMES'S PROPERTY

On the east side of Round mountain, there is exposed only one outcropping of coal, that can be correlated with the Tatum seam.



The exposure, here referred to, occurs in a recent excavation on *lot 312, 10th district*, within a short distance of the east prong of Rock creek. The outcrop is to be seen in a

hollow, north of an old roadway leading up the hill, just west of Mr. J. J. Moore's house, where the following section was made out:—

1 Shale	-----	8 feet
2 Coal	-----	21 inches
3 Fire-clay	-----	18 " (?)
4 Shale (concealed)	-----	(?)
5 Sandstone	-----	(?)

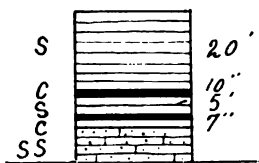
J. J. MOORE'S PROPERTY

In addition to the above outcrop of coal, there is a lower seam, to be seen near the base of the hill in the roadside, a few hundred yards east of the James exposure. This outcrop is located on Mr. J. J. Moore's property, *lot 311, 10th district*; and it lies 80 feet or more below the James exposure. The outcrop along the road reveals the following section : —

1 Shale	20 feet
2 Coal Smut	10 inches
3 Shale	5 feet
4 Coal Smut	7 inches
5 Fire-clay	2 feet
6 Sandstone	(?)

Another exposure of coal on Lookout, east of Round mountain, occurs on *lot 63, 10th district*, about three-quarters of a mile east of the Allison bank. The outcrop appears in the form of a thin layer of coal, associated with fire-clay and disintegrated sandstone. The seam lies several feet above the Allison bank, and is supposed to correspond with one of the coal seams previously spoken of as outcropping above the Durham seam on Round mountain. The remaining coal exposures in Walker county are confined to the brows of Lookout and Pigeon mountains, and are described as follows : —

Fig. 15.



EXPOSURES OF COAL ON THE EAST BROW OF LOOKOUT MOUNTAIN, SOUTH OF EAGLE CLIFF. — The first exposure of coal on the east brow of Lookout mountain, south of Eagle cliff, with the exception of the outcrop at Nickajack gap, above described, is to be seen at Cooper gap, 2 1-2 miles southeast of Round mountain. Between these two gaps, there are said to be traces of coal at a few points along the sandstone bluff ; but there is no actual outcrop of

what might be termed a coal seam of any promise. The main exposure at Cooper gap occurs in the public road, only a few rods west of the point, where it turns down the eastern slope of the mountain. The coal seam, which is here represented by coal smut, is apparently about 12 inches in thickness. No attempt had been made at the time of our visit to expose the coal; and, as a consequence, no satisfactory section could be made out. However, judging from the residual product, the coal is most likely found in the sandstones with a thin stratum of fire-clay beneath.

A short distance east of this exposure, and just beyond where the road commences to descend the steep mountain slope, is another indication of coal, also represented by a thin band of coal smut. These coal seams, which are separated by several feet of sandstone, are thought to represent the first and second bluff seams on the west side of Lookout mountain, hereafter to be described.

EXPOSURE OF COAL AT STEPHEN'S GAP.—The outcrop of coal at Stephen's gap occurs on Mrs. J. W. Bryan's property, *lot 154, 11th district*, only a short distance west of the public road leading from Cassandra to Johnson crook. There are three different exposures of coal on the property, two of which are located on the brow of the mountain, and the other, well down the slope towards the valley. The last named exposure was discovered during the summer of 1900; and, for a time, it created considerable excitement among the land owners in that vicinity. It is located on the north side of the public road, about two thirds of the way down the mountain, and only a short distance above the outcrop of the Bangor limestone. The coal is here revealed in two recent excavations, not over 50 yards apart. The excavation nearest the road is four or five feet deep. It exposes, just beneath what appears to be a huge sandstone boulder, an irregular mass of coal and shale, about three feet thick. The coal is mostly in the form of smut, and it shows every indication of having been



much disturbed. In the other excavation, the coal has a maximum thickness of 24 inches, and is more distinctly stratified. Nevertheless, there is even here marked evidence of local disturbance. The huge sandstone masses in the vicinity, which are much disarranged, have every appearance of having been left in their present position by a landslide. There is an area here of some two or three acres, that seem to have slidden *en masse* from the summit of the mountain above.

A similar landslide, though of much less size, is to be seen on the side of the mountain a short distance north of the above point. This landslide, embracing an area of something like a quarter of an acre, broke loose from the mountain side during the rainy season, a year or so ago; and, though it moved only a few yards, it appeared to extend to a considerable depth, as trees of large size were moved, without having their upright position disturbed. These landslides are due to the loosening of large masses of sandstone and earth, which have been undermined by the wearing away of the underlying shales. Evidence of such catastrophes are of common occurrence at many points along the mountain slope, both north and south of Stephen gap.

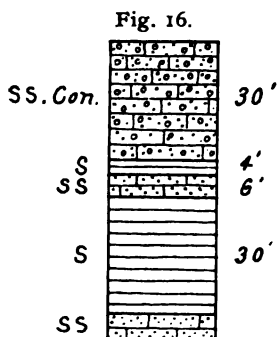
The other two exposures of coal at Stephen gap, referred to above, are both on the mountain, only a short distance from Mrs. Bryan's residence. One of the exposures is on the brow of the mountain, a few rods south of where the public road descends the mountain; and the other is west of the residence, some two or three hundred yards. The coal on the brow of the mountain is to be seen in a small open-cut, where it occurs in the form of small seams or partings in a stratum of black shale. The limited amount of prospecting, done here, gives but a very imperfect idea of the extent or nature of the coal. However, from the several outcrops near by, it seems to be quite probable, that the coal found here corresponds to the lower coal seam in Johnson crook. The ex-

posure of the rock in the immediate vicinity of the coal outcrop, shows the following section :—

- | | | |
|---|--|----------|
| 1 | Coarse-grained Sandstone and Conglomerate... | 10 feet |
| 2 | Black Shale with partings of Coal..... | 15 " (?) |
| 3 | Sandstone | (?) |

North of this point, about half-a-mile, occupying apparently the same relative position on the mountain, are to be seen other small prospect-pits beneath a sandstone bluff ; but no coal is exposed to view. At this point, the section below was made out :—

- | | | |
|---|--|---------|
| 1 | Coarse-grained Sandstone and Conglomerate... | 30 feet |
| 2 | Shale | 4 " |
| 3 | Sandstone | 6 " |
| 4 | Shale | 30 " |
| 5 | Sandstone | (?) |



The shales in the above section, especially the stratum just below the heavy bed of sandstone forming the cliff, is more or less fossiliferous, and has, in places, every appearance of an old fossil soil. At one or two points between these prospect-pits and Cooper gap, traces of coal are reported along the cliffs; but no attempt has been made to investigate their significance.

The exposure of coal, west of the Bryan residence, occurs at the base of a small bluff of conglomerate, which sits back some 200 or 300 yards from the brow of the mountain. The surface of the mountain at this point slopes gradually to the west; and, as a consequence, the base of the cliff of conglomerate lies 20 or 30 feet below the brow of the mountain. Nevertheless, the sandstone outcrop on the brow, geologically speaking, lies many feet below the bluff of conglomerate. This is due to a steep dip of all the formations to the west. It is impossible to ascertain from the meagre

exposure, the exact distance, that the coal at the base of the conglomerate lies above the coal exposed on the brow of the mountain. However, it probably does not exceed 80 feet. The coal at the base of the bluff of conglomerate, consists of an irregular seam, two or three inches in thickness. Just below the conglomerate, is a stratum of black shale. The natural position of the coal would, therefore, seem to be between these formations; but, on the contrary, it is confined mainly to the conglomerate, where it seems to fill irregular fissures. Between the exposure at the bluff of conglomerate and Mrs. Bryan's residence, is to be seen another indication of a coal seam; but, at the time of our visit, its extent had not been investigated.

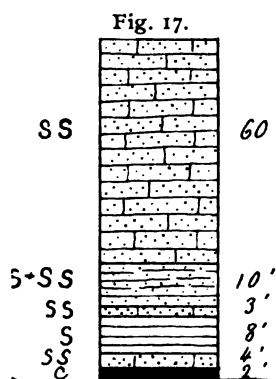
South of Stephen gap, there are numerous indications of coal along the sandstone bluffs; but no actual exposure of coal appears until the head of McLamore's Cove is reached. The exposure here is located at the base of a cliff on *lot 103, 12th district*, owned by Messrs. Owen and Millican (?). The coal seam is said to have a maximum thickness of about 12 inches, and it is thought to be the same as the coal seam exposed on the brow of the mountain, just south of the public road at Stephen gap.

EXPOSURE OF COAL ON PIGEON MOUNTAIN

The coal exposed on Pigeon mountain is confined entirely to its eastern side. The exposure, lying furthest to the north, is located in a small ravine on the side of the mountain, about 1 1-2 miles north of Dougherty gap. The coal seam attains a thickness of something like 12 inches, and is overlain by a heavy bed of sandstone. The seam probably extends further north; but, at no point along the mountain in that direction, is coal reported to be exposed to view.

The most extensive outcrop of coal on Pigeon mountain is located on Mr. W. L. Alexander's property, *lot 200, 12th district*,

about two miles southeast of Dougherty gap. There are three exposures on the above named lot, all located in what is known as Guyton gulch. The most extensive exposure is to be seen at a recent excavation on the hillslope, something like 150 feet above the bottom of the gulch. The excavation, which is a drift extending into the hill to a distance of 30 feet, exposes, at its entrance, a coal seam 24 inches thick. At the far end of the drift, the coal is reported to increase in thickness to about 30



inches. The flooded condition of the drift prevented this report, however, from being verified by a personal examination. The coal seam, as is shown by the exposure at the entrance to the drift, where it is much weathered, contains a considerable amount of slate. The seam dips at a low angle to the west, and has an elevation of 680 feet (aneroid measurement) above the eastern base of the mountain. About 70 feet below the above excavation, near the stream in

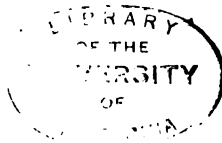
the gulch, are other traces of coal in the sandstone bluff. The coal here, however, seems to partake more of the nature of small irregular pockets in the sandstone, than of a well defined seam. The following section shows the order of succession and the thickness of the rocks, from the main coal seam here exposed, to the top of the hill, on which the excavation is located :—

1	Heavy-bedded Sandstone	60 feet
2	Shaley Sandstone	10 "
3	Sandstone	3 "
4	Shale	8 "
5	Sandstone	4 "
6	Coal	2 "
7	Fire-clay	2 "

The second exposure of coal on lot 200, is on the south prong of

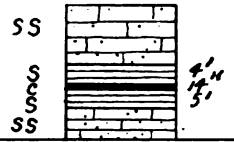


EAST ENTRANCE TO THE COAL MINES OF THE DURHAM COAL AND COKE COMPANY, ROUND MOUNTAIN, WALKER COUNTY, GEORGIA.



Guyton gulch, about half-a-mile west of the above excavation. The coal seam at this point has a thickness varying from 12 to 14 inches, and it dips at a low angle to the west. Coal from this outcropping has been used on the mountain, to a limited extent, for blacksmith purposes, and it is reported to have given very satisfactory results. It is a clean, bright coal, quite free from shale and other mechanical impurities. From the exposures along the branch and on the hillslope, near the coal outcrop, the following section was made out:—

Fig. 18.



1 Cross bedded Sandstone	(?)
2 Shale	4 feet
3 Coal	14 inches
4 Indurated Fire-clay	2 feet
5 Shale	3 "
6 Sandstone	(?)

On the opposite side of the gulch, and only a few rods away, is a second exposure of what appears to be the same coal seam. The dip, however, at this point is to the east at an angle of about 20 degrees. The exposures of coal in Guyton gulch are considered the most promising of any, heretofore examined on the eastern brow of either Lookout or Pigeon mountains.

CHAPTER V

THE COAL DEPOSITS OF CHATTOOGA COUNTY

The coal deposits of Chattooga county are limited to a small area in its northwest corner, along the Georgia-Alabama State-line. The exposures of coal here, as in Walker county, occur near, or on, the eastern brow of Lookout mountain, at an elevation varying from 500 to 600 feet above Chattooga valley.

THE TRION FACTORY PROPERTY

The first indication of coal to be seen on Lookout, south of the Walker county-line, is on the Trion Factory property, *lot 127, 13th district*, about $1\frac{1}{2}$ miles from the west brow of the mountain. Coal occurs here on the top of the mountain, in a somewhat swampy depression not far from a small chalybeate spring, the source of one of the main tributaries of Little river. The Trion Factory people, some years ago, did considerable work on this property, with the hope of finding a workable coal seam. The workings, which consist of a number of shallow open-cuts, are now all more or less filled with earth and water, so that no coal is exposed *in situ*. On the dumps, small fragments of bright, clean coal are to be seen mingled with fragments of black shale and water-worn pebbles. The surface near the excavations are strewn with boulders of conglomerate, from which the water-worn pebbles have evidently been derived. Judging from the surface boulders and the dump at the pits, the coal seam appears to occur beneath the conglomerate, and is underlain by, or associated with, black shale. Mr. Guyton, who lives near the excavations, in

formed the writer, that, at a depth of three or four feet from the surface, coal was found in nearly all the pits. According to his statement, it does not occur in a regular seam; but it is found in pockets, more or less mixed with shale.

About 1 1-2 miles southwest of the Trion property, is another exposure of coal at Gilreath mill, on the south fork of Little river. The coal seam here, found beneath the sandstone forming the cascade near the mill, attains a thickness of only a few inches. East of this exposure, some two miles, and only a short distance north of Neal gap, is still another outcrop of coal. This seam is reported by Dr. Spencer to outcrop beneath the conglomerate and to vary in thickness from 12 to 18 inches.

EXPOSURES OF COAL ALONG THE SOUTH FORK OF LITTLE RIVER

Along the south fork of Little river, southwest of Gilreath mill, several small exposures of coal are reported. One of these is to be seen on H. C. Jennings's property, *lot 295, 13th district*, about 3 1-2 miles northwest of Menlo. This exposure is on the right bank of the river, just north of the public-road crossing, at which place a limited amount of work has been done in mining coal for blacksmith purposes. The excavation is now partly filled with earth, so that the coal seam is exposed at only one point. The seam, where exposed to view, has a thickness of about 10 inches; but, in places, it is reported to attain a thickness of 18 inches. It is overlain by a heavy bed of sandstone, and dips to the west at a low angle. On an adjoining lot, *No. 312*, also owned by Mr. Jennings, is another outcrop of coal. This exposure, which occurs on the surface as coal smut, is in the public road, about 300 yards west of Mr. Jennings's residence, and near a chalybeate spring. The outcrop, which indicates a coal seam from 6 to 10 inches in thickness, lies something like 50 feet above the seam, exposed at the

river. Only a short distance west of the above exposures, several outcrops of coal are reported along the south fork of Little river. These exposures, however, are all in Alabama; and, as a consequence, they were not investigated.

CHAPTER VI

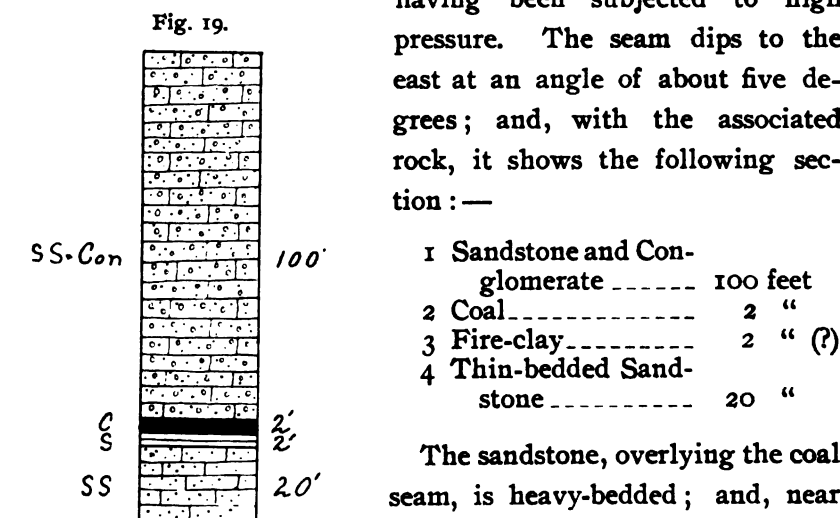
THE COAL DEPOSITS OF DADE COUNTY

Prior to 1891, all the coal mined in Georgia was obtained from Dade county. The coal area of this county exceeds that of any other county in the State. The deposits are confined to the western side of Lookout and the northern extension of Sand mountains. The deposits on Lookout mountain have never, so far, been worked to any extent. Nevertheless, the exposures, in places, as will be seen in the following descriptions of the individual outcrops, appear to be of considerable promise.

EXPOSURE OF COAL ALONG THE WEST SIDE OF LOOKOUT MOUNTAIN

The first exposure of coal, of any importance, occurs near Nickajack gap, two miles east of New England City, on the west side of Lookout mountain, south of the Georgia-Tennessee State-line. The exposure is located on a high sandstone cliff on T. S. Miller's property, *lot 225, 10th district*, something like 300 yards south of the old breastworks, which, during the war between the States, commanded the roadway in the gap of the mountain. The coal, at this point, was worked to a limited extent, some years ago, to obtain coal for local blacksmith purposes. The main excavation consists of a short drift, originally 10 or 15 feet in length, extending back beneath the sandstone cliff. The walls of the excavations are now much weathered and fallen in, so that no fresh coal is exposed to view. The seam is apparently very irregular in thickness. At one point, it is fully four feet; but its general aver-

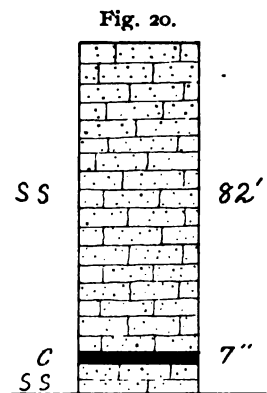
age would probably not exceed 24 inches. The coal is smutty, somewhat slaty, and much crushed, and shows every evidence of having been subjected to high pressure. The seam dips to the east at an angle of about five degrees; and, with the associated rock, it shows the following section:—



The sandstone, overlying the coal seam, is heavy-bedded; and, near the top of the cliff, it passes into a conglomerate, which is the surface rock on the brow of the mountain. South of Nickajack gap, no other exposure of coal, of note, is reported on the west side of Lookout mountain, until Sitton gulch is reached, 1 1-2 miles east of Trenton.

JOSEPH JOHNSON'S PROPERTY

In ascending the east fork of Bear creek, the stream traversing the gulch, the first outcrop of coal to be seen is at the base of a waterfall on lot 42, 11th district. The coal seam, here exposed, has a thickness varying from 5 to 12 inches; and it apparently dips at a low angle in different directions on the two sides of the gulch. The coal has both a columnar and a laminated structure; and it seems to be quite free from shale and



other impurities. The exposure along the side of the gulch at the waterfall, shows the following section :—

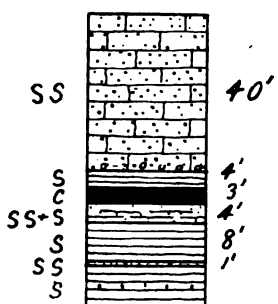
1 Sandstone (heavy-bedded) -----	70 feet
2 Sandstone (thin-bedded) -----	8 " (?)
3 Sandstone with numerous casts of coal plants	4 "
4 Coal -----	7 inches
5 Fire-clay -----	18 "
6 Sandstone -----	(?)

In the gulch, a few hundred yards below the point at which the above section was made out, and near the junction of the east and west forks of Bear creek, is an exposure of about 50 feet of black shale containing numerous concretions of siderite (iron carbonate). The outcrop of this shale, above which all the coal seams are supposed to lie, has an altitude of 500 feet (aneroid measurement) above Lookout creek.

WALTER WOOD'S PROPERTY

A second exposure of coal in Sitton gulch occurs on *lot 67, 11th district*, something like a quarter of a mile southeast of the exposure just described. The coal seam is to be seen at two different points along the bluff, at an elevation of 40 feet above the bottom of the gulch. The exposures are not over 100 yards apart. The one, furthest down the gulch, is a natural outcrop at the base of a small sandstone bluff. The coal seam at this point, which appears to be greatly enlarged, attains a maximum thickness of four feet. The coal is badly crushed, and is more or less mixed with fragments of shale. The other exposure is in an open-cut, 8 or 10 feet long and about 4 feet deep at its upper end. The coal seam is here 14 inches thick, and it contains but little shale. The fol-

Fig. 21.



lowing section shows the character and thickness of the rocks associated with the coal seam at the above exposures :—

1 Sandstone	40	feet
2 Conglomerate	8	inches
3 Shale	4	feet
4 Coal	14 inches to 4	"
5 Shale	2	"
6 Sandstone	2½	"
7 Shale	8	"
8 Sandstone	1	"
9 Shale with thin layers of Sandstone	(?)	

The coal seam, exposed on lot 67 is 350 feet below the surface of the mountain on either side of Sitton gulch, and is probably 100 feet above the coal seam exposed on lot 42. Between these two seams, there is a third exposure of coal in the gulch, about 50 yards south of the lower outcrop on lot 67. The seam occurs in sandstone, and is only two or three inches in thickness.

THE WHITE OAK SPRINGS EXPOSURE. — Another exposure of coal in the vicinity of Sitton gulch occurs near White Oak Springs, on lot 41, 11th district. This is also owned by Mr. Walter Wood. Coal is found here in a small ravine, on both sides of which the coal was formerly exposed in two shallow open-cuts. These excavations are now well filled with earth, so that no coal, except that found on the dumps, is exposed to view. The coal in the bottom of the excavations is reported to be several inches in thickness, and quite free from shale. The limited outcrop of the rock in the vicinity of the prospect-pits, makes it impossible to secure a section showing the relative positions of the coal with reference to the associated strata. It is quite likely, that this coal seam corresponds to one of the seams outcropping in the gulch. However, the data at hand is too meagre to demonstrate the fact.

Passing southward from Sitton gulch, the first indication of coal to be seen along the west side of Lookout mountain, is on the public road leading from Trenton to Stephen gap. The exposure,





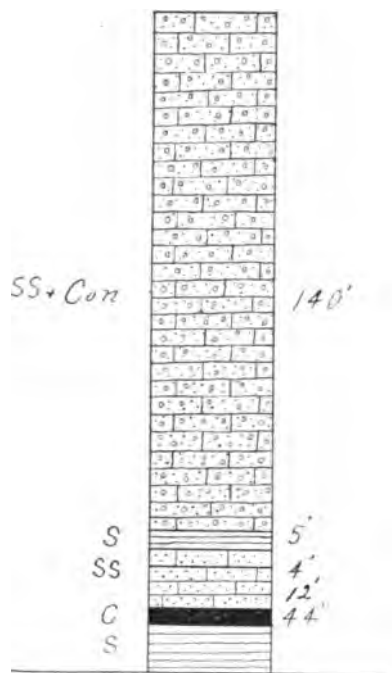
which occurs just below the sandstone bluff forming the brow of the mountain, consists of a small seam, not over two inches in thickness.

THE PHOENIX IRON AND COAL COMPANY'S PROPERTY

Further to the south on the Phoenix Iron and Coal Company's property, *lot 74, 11th district*, is another exposure, of much more promise. The coal on this property, outcrops at the base of a sandstone cliff on the side of the mountain, 980 feet above Look-out creek. The best exposure of the seam is in the short tunnel, at which point the following section was made out:—

- | | |
|--|-----------|
| 1 Sandstone and conglomerate forming the top of the mountain | 140 feet |
| 2 Shale | 5 " |
| 3 Thin-bedded Sandstone | 4 " |
| 4 Heavy-bedded Sandstone | 12 " |
| 5 Coal (bluff seam) | 44 inches |
| 6 Fire-clay | 18 " |
| 7 Shale | (?) |

Fig. 22.



About 200 yards south of the above tunnel, is a second exposure of this same coal seam in another small excavation. The coal at both exposures is much crushed and folded, and is more or less mixed with fragments of shale. The dip of the coal seam, together with the associated rocks, is to the east at an angle of about 15° . On the side of the mountain, a short distance below the outcrop of the coal seam

here described, is to be seen a large open-cut, made several years ago with a view of locating a coal seam at a lower level. This work is reported to have been entirely unsuccessful, revealing nothing except black shale.

THE GEORGIA IRON AND COAL COMPANY'S PROPERTY

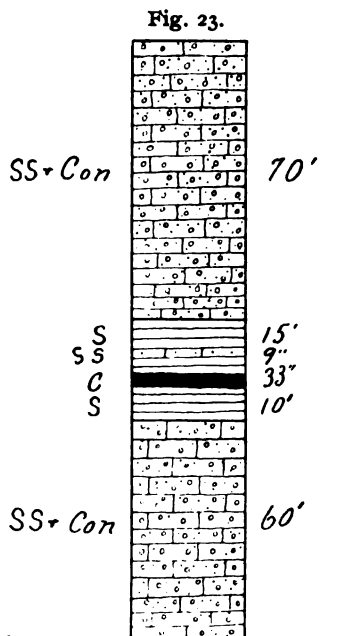
South of the Phoenix Iron & Coal Company's property are the extensive land interests of the Georgia Iron & Coal Company. This property, besides embracing much of Johnson crook, includes a large part of all the land on the west side of Lookout mountain, as far south as Forester gulch. There are a number of exposures of coal on this property, which are here described in their consecutive order southward.¹

THE HANNA BANK

This exposure of coal is located on *lot 144, 11th district*, below the sandstone cliffs, which form the brow of the mountain. The coal seam has a maximum thickness of about three feet, and it appears to dip at a low angle to the east. Overlying the coal seam, which has been worked to a limited extent by the local blacksmiths, are many feet of sandstone conglomerate; but the outcrops are not sufficiently exposed to enable an accurate section to be made out. This coal seam is probably the second cliff seam. However, the limited exposures of the associated rock are not sufficient to definitely decide this question.

DRIFT NO. I. — This excavation,

¹ See map of the Cole City District.



which was made in 1898 by the Dade Coal Mining Company, has a length of only 40 feet. It is located at the base of a sandstone bluff on *lot 60, 11th district*, 80 or 90 feet below the top of the mountain. The coal seam dips nearly due east at an angle of about 10° ; and, with the associated rocks, it gives the following section :—

1 Sandstone and Conglomerate.....	70 feet
2 Shale.....	15 " (?)
3 Sandstone.....	9 inches
4 Shale.....	5 feet
5 Coal.....	33 inches
6 Shale.....	10 feet
7 Sandstone and Conglomerate.....	60 "

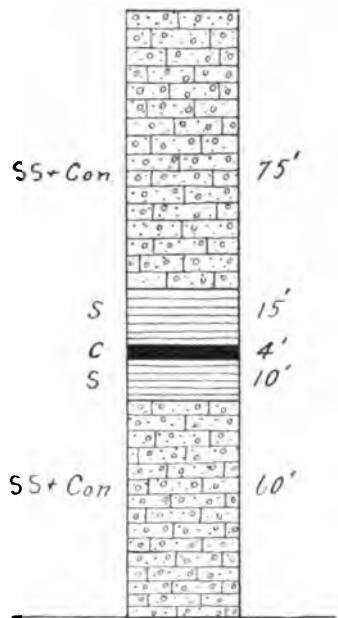
The coal seam, exposed here, as elsewhere along the west side of Lookout mountain, is more or less broken and mixed with shale.

DRIFT No. 2.—This is located on *lot 181, 11th district*, an eighth of a mile northwest of High Point. The drift was made in 1898. It is reported to extend into the mountain for a distance of 155 feet. The section exposed here to view is as follows :—

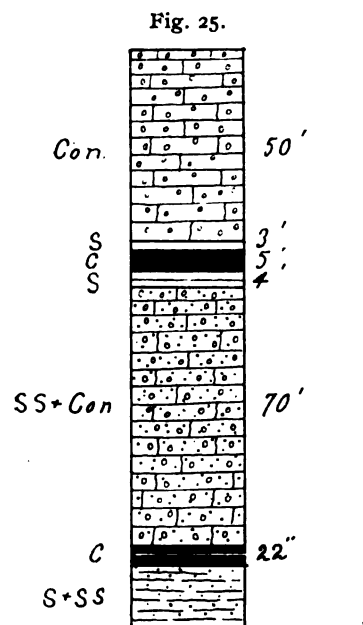
1 Conglomerate forming top of the mountain.....	75 feet
2 Shale.....	15 "
3 Coal (upper cliff seam) with more or less Shale.....	3 to 5 "
4 Shale.....	10 "
5 Sandstone and Conglomerate.....	60 "

The coal seam dips nearly due north, at an angle of about 10° .

Fig. 24.



HIGH POINT, LOT 182, 11TH DISTRICT.—There are two coal



seams exposed at High Point, one above, and the other just below, the cliff forming the point. The one below the cliff, is exposed in an old drift, 100 feet in length; while the one above the cliff, occurs in an open-cut, in a low sag on the mountain, only a few rods back from the top of the cliff. The lower coal seam is now the only one exposed to view, the other being concealed by detritus washed in from the sides of the sag.

The section below gives the thickness and the relative position of the several strata exposed at High Point:—

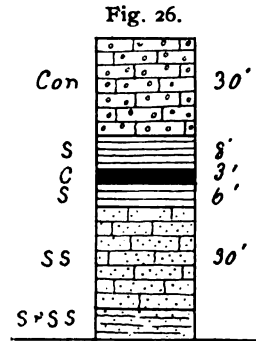
1 Conglomerate (top of mountain)	50 feet
2 Shale	3 "
3 Coal (upper cliff seam)	5 " (?)
4 Shale	4 " (?)
5 Sandstone and Conglomerate	70 "
6 Coal (cliff seam)	10 inches
7 Shale (" ")	1 "
8 Coal (" ")	16 "
9 Shale (lower cliff seam)	5 "
10 Coal (" " ")	6 "
11 Sandstone, with casts of plants	(?)

Below the sandstone with the casts of plants, occur partly concealed beds of shale and sandstone, the thickness of which could not be determined. The dip of the lower coal seam at the entrance of the drift, is 9° ; but further in, it is reported to be much less. Owing to the flooded condition of the drift at the time of

our visit, no very satisfactory examination of the coal could be made.

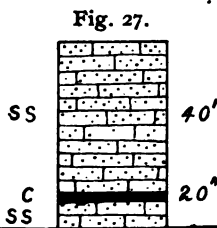
DRIFT No. 3. — This drift is located near the summit of the mountain, about three-quarters of a mile northeast of High Point, on lot 178, 11th district. The coal seam here exposed is the same as the upper seam at High Point, as is shown by the following section : —

- | | |
|------------------------------|----------|
| 1 Sandstone and Conglomerate | 30 feet |
| 2 Shale | 8 " |
| 3 Coal (upper cliff seam) | 1 to 3 " |
| 4 Shale (concealed) | 6 " |
| 5 Sandstone | 30 " |
| 6 Shaly Sandstone | (?) |



Dip of coal seam, 10° northeast.

DRIFT No. 4 is located on lot 148, 11th district, one mile northeast of drift No. 3. It was made in 1898, and has a total length of about 40 feet. The section here exposed is given below : —

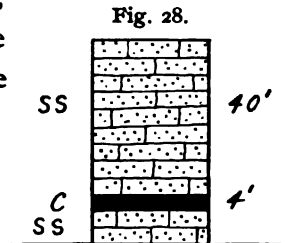


- | | |
|-----------------------------------|-----------|
| 1 Sandstone exposed | 40 feet |
| 2 Coal (cliff seam) | 20 inches |
| 3 Sandstone, with casts of plants | (?) |

This coal seam, which corresponds to the lower coal seam exposed at High Point, dips at an angle of about 5° to the northeast.

THE MCCAG OPENING. — This is an old working, made more than 20 years ago. It is located on lot 149, 11th district, within a short distance of the top of the mountain, where is exposed the following section : —

- | | |
|----------------------------------|----------|
| 1 Sandstone | 40 feet |
| 2 Coal | 3 to 5 " |
| 3 Sandstone with casts of plants | (?) |

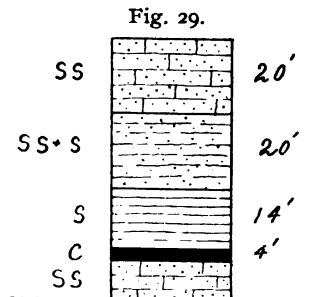


Dip, 10° north, 20° east.

The excavation is now much fallen in, and flooded with water, so that nothing, except the weathered outcrop of the coal seam can be seen.

THE RISING FAWN COAL MINE.—The Rising Fawn coal mine, now owned by the Georgia Iron & Coal Company, of Rising Fawn, Ga., is located on *lot 150, 11th district*, about half-a-mile nearly due east from the McCag opening, and within a short distance from the top of the mountain. The mine was opened just after the Rising Fawn furnace was put in blast; but, for some reason, only a small amount of coal was mined. The most of the work is said to have been confined to a single drift, which is reported to have been driven into the mountain for a quarter of a mile. Dr. George Little, formerly State Geologist of Georgia, in speaking of the Rising Fawn coal mine in 1876, says: "On the Dade side of the mountain, the coal has been opened near the summit of the cliff in Johnson gulf, in a vein four or five feet thick, and an incline built by which the coal is brought down to the foot, and thence by a narrow-gauge railroad, carried four miles to Rising Fawn furnace, where 60 improved Belgian coke ovens have been constructed for supplying fuel for their 50 ton stack."¹ The Rising Fawn Furnace Company appears to have realized but little profit from the improvements here spoken of; as only small amounts of coal were ever made into coke. The entrance to the mine is now inaccessible. However, the exposure along the side of the mountain shows the following section:—

- | | |
|--|----------|
| 1 Sandstone, top of the mountain ----- | 20 feet |
| 2 Sandstone and shale partly exposed ----- | 20 " (?) |
| 3 Shale with nodules of iron carbonate ----- | 14 " |
| 4 Coal ----- | 3 to 5 " |
| 5 Sandstone with casts of plants ----- | (?) |



¹ Hand-book of Georgia, page 45.

The coal seam is the same as the lower seam exposed at High Point. Nevertheless, there seems to be considerable difference in the overlying strata.

Analyses of coal from the Rising Fawn mine show the following results : —¹

	I	II	III
Fixed Carbon.....	76.59	75.60	75.080
Volatile Matter.....	20.01	19.89	17.240
Ash.....	2.96	3.92	7.680
Sulphur.....	1.09	—	1.270
Phosphorus.....	—	—	.006
Total.....	<u>100.65</u>	<u>99.41</u>	<u>101.276</u>

DR. A. T. FRICKS' PROPERTY

In going south from Johnson crook, coal is to be seen on Dr. A. T. Fricks' property, *lot 157, 11th district*, at the mouth of Forester's gulf. The outcrop occurs on the side of the mountain, 570 feet above Lookout valley, where the coal is exposed in a short drift at the juncture of the north and south forks of the gulf. The section here exposed is as follows : —

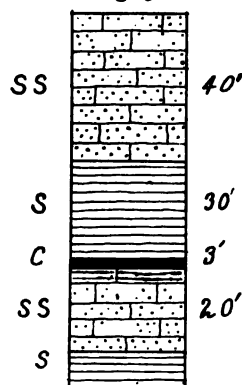
1 Sandstone.....	40 feet
2 Shale.....	30 "
3 Coal.....	2 to 3 "
4 Fire-clay.....	18 inches
5 Shale.....	2 feet
6 Sandstone.....	20 "
7 Shale.....	(?)

Dip, 10° S., 40° E.

On the north fork of Forester's gulf, something like a mile from the above

exposure, is another outcrop of coal. The exposure occurs at the base of a high waterfall, 900 feet above Lookout valley, at which point the following section is revealed : —

Fig. 30.



¹ Geol. Surv. of Georgia, *The Paleozoic Group*, by J. W. Spencer, p. 259.

- | | |
|--------------------------------------|-----------|
| 1 Heavy-bedded Sandstone | 30 feet |
| 2 Sandstone, thin-bedded | 20 " |
| 3 Coal | 10 inches |
| 4 Sandstone and thin layers of Shale | 20 feet |

An exposure, very similar to the above, is found on the south fork of Forester's gulf, three quarters of a mile from the Fricks opening. The outcrop here, as on the north fork, is at the base of a sandstone cliff. The two exposures have practically the same elevation above Lookout valley, and they are undoubtedly one and the same coal seam. Between the Fricks opening and the exposure on the south fork of the gulf, there is a small outcrop of coal, which is supposed to correspond to the upper coal seam on the north side of Johnson crook.

Fig. 31.

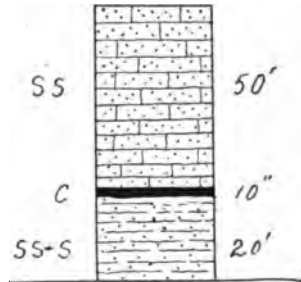
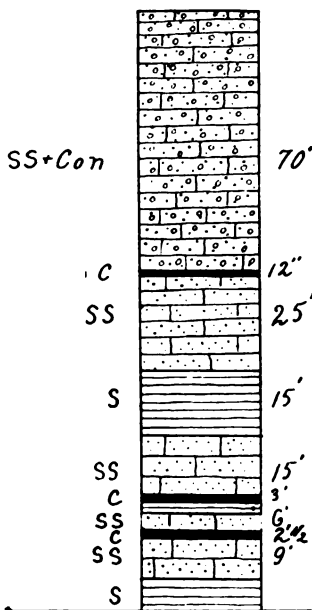


Fig. 32.



EXPOSURE OF COAL AT STEPHEN GAP. — Stephen gap is located about a mile south of Forester's gulf, at which point the following section may be seen: —

- | | |
|------------------------------|-----------|
| 1 Sandstone and Conglomerate | 70 feet |
| 2 Coal | 12 inches |
| 3 Sandstone | 25 feet |
| 4 Shale | 15 " |
| 5 Sandstone | 15 " |
| 6 Coal | 2 to 3 " |
| 7 Fire-clay | 4 " |
| 8 Sandstone | 6 " |
| 9 Shale with traces of Coal | 2½ " |
| 10 Sandstone | 9 " |
| 11 Shale | (?) |

Lying above the section here given, there is said to be a third





coal seam, about 12 inches thick, immediately below the conglomerate which forms the top of the mountain.¹ The rocks at Stephen gap dip 20°, S. 30° E.

TATUM GULCH

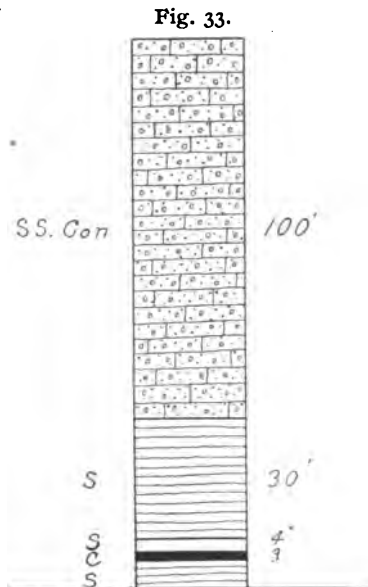
Between Stephen gap and the Georgia-Alabama State-line, other outcrops of coal are reported in the Tatum gulch and near Sulphur Springs gap. The latter point was visited by the writer; but the excavation exposing the coal was filled with earth, and no coal was exposed to view. The outcrop of the rocks along the public road near the top of the mountain gives the following section:—

1 Sandstone	50 feet
2 Shale with traces of Coal	20 "
3 Sandstone	20 "
4 Shale	(?)

EXPOSURE OF COAL ON FOX MOUNTAIN

There are only two exposures of coal on Fox mountain—one on the east, and the other on the west side. The exposure on the east side is on D. G. Evatt's property, *lot 84, (?) 18th district*, about three quarters of a mile west of Rising Fawn. The coal outcrops here near the top of the mountain, where the following section is revealed:—

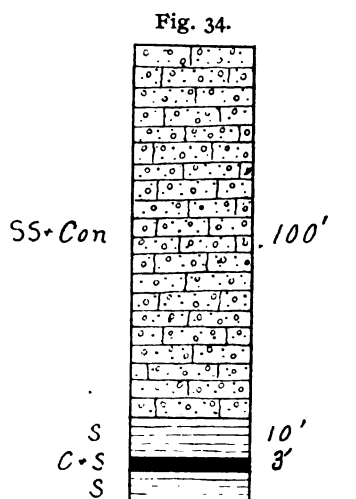
1 Sandstone and Conglomerate	100 feet
2 Shale	30 "
3 Clay with impressions of Plants	4 "
4 Coal; more or less mixed with Shale (cliff seam)	3 "
5 Shale	(?)



¹ Geol. Surv. of Georgia, *The Paleozoic Group*, by J. W. Spencer, p. 256.

At one point on the Evatt property, an effort was made some years ago to prospect the coal seam ; but, after driving a drift into the mountain for several feet, the work was abandoned on account of water. In the vicinity of the excavations, the rocks all dip northwest at an angle of about 30° .

THE L. W. NICHOLS PROPERTY



The exposure on the west side of Fox mountain is located on L. W. Nichols' property, *lot 96, 18th district*, within a few rods of the Georgia-Alabama State-line. The position of the coal at this exposure may be seen in the following section : —

- | | |
|---------------------------------------|-----------|
| 1 Sandstone and Conglomerate | 100 feet |
| 2 Shale | 10 inches |
| 3 Coal mixed with Slate, (cliff seam) | 3 feet |
| 4 Shale | (?) |

The coal seam, which is exposed in a natural outcrop at the base of a sandstone cliff, dips to the southeast at an angle of about 20° . The two sections above given show that the coal-seam outcrops, on the east and on the west sides of Fox mountain, occupy the same stratigraphical position. The seam is thought to represent the lower or cliff seam, exposed at High Point.

EXPOSURE OF COAL ON THE EAST SIDE OF SAND MOUNTAIN

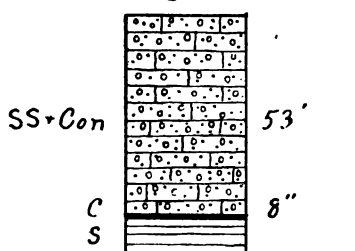
The southernmost exposure of coal on the east side of Sand mountain is to be seen on the New England Company's property, *lot 30, 18th district*, less than half-a-mile from the Georgia-Alabama State-line. The outcrop of coal occurs in the southwest corner of

the lot, at the base of a sandstone cliff forming the brow of the mountain, where the section below was made out:—

1 Sandstone and Conglomerate	25 feet
2 Cross-bedded Sandstone	8 "
3 Massive Sandstone with some waterworn pebbles	20 "
4 Sandstone with numerous small cavities	8 inches
5 Fire-clay	8 "
6 Coal (cliff seam)	8 "
7 Fire-clay	18 "
8 Shale	(?)

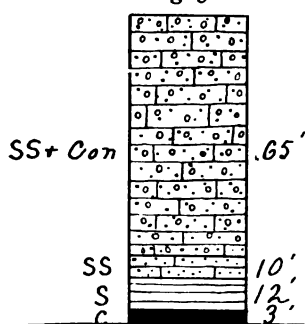
This coal seam is exposed at different points along the bluff for a quarter of a mile or more to the south, where it passes into Alabama. The coal is clean, and appears to be of fair quality. It is reported to have been used to a limited extent for smithing purposes, and it is said to have given satisfaction. The seam outcrops 700 feet above Look-out valley, and dips about 15° to the northwest.

Fig. 35.



THE JACKSON COAL AND COKE COMPANY'S PROPERTY

Fig. 36.



Passing north from the above exposure, the first outcrop of coal to be seen is on the Jackson Coal and Coke Company's property, lot 143, 19th district. The exposure of coal on this lot occurs in two short drifts on the side of the public road in White Oak gap, about 80 feet below the top of the mountain. The two excavations, which were made some years ago, are now flooded with

tions, which were made some years ago, are now flooded with

water, and are inaccessible. The following section shows the thickness and character of the rock associated with the coal, as revealed in the natural outcrop:—

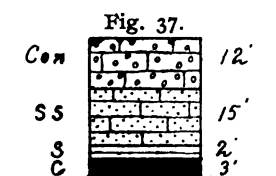
- | | |
|--|---------|
| 1 Sandstone and Conglomerate forming the top of the mountain | 65 feet |
| 2 Thin-bedded Sandstone | 10 " |
| 3 Shale | 12 " |
| 4 Coal (cliff seam) more or less mixed with Slate | 3 " |
| 5 Concealed | (?) |

The coal seam at this point dips to the northwest at an angle of 5°.

THE NEW ENGLAND COMPANY'S PROPERTY

About a quarter of a mile west of White Oak gap, on the road leading from Trenton to Bridgeport, is another exposure of coal. This exposure, which is a natural outcrop on the roadside, is located near the center of *lot 144*, owned by the New England Company. The elevation of the outcrop is 720 feet above Look-out valley, which is about 30 feet below the outcrop at White Oak gap. The rocks in the vicinity of the exposure dip to the west at an angle varying from 10° to 15°, and

show the following section:—



- | | |
|---|---------|
| 1 Conglomerate forming sur-
face of mountain | 12 feet |
| 2 Thin-bedded Sandstone | 15 " |
| 3 Shale | 2 " |
| 4 Coal smut | 3 " |

On the same lot, a short distance northeast of the above point, the New England Company put down a bore-hole, which gave the following section:—

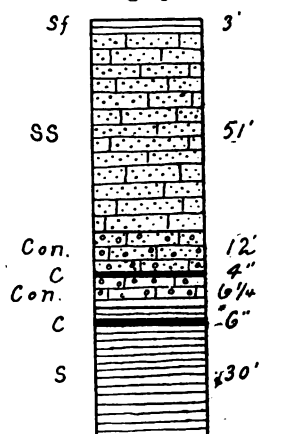


ENTRANCE TO THE RACCOON COAL MINE, COLE CITY, DADE COUNTY, GEORGIA.



1 Surface	3.00 feet
2 Sandstone	51.00 "
3 Conglomerate	12.00 "
4 Coal	0.35 "
5 Conglomerate	6.25 "
6 Shale	2.25 "
7 Coal	0.5 "
8 Shale	30.00 "

Fig. 38.



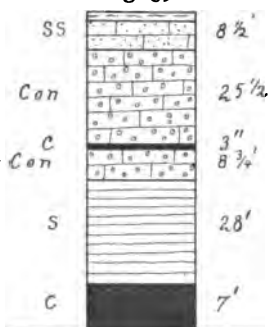
A second exposure of coal, on the Trenton-Bridgeport public road, occurs on lot 151, 19th district, 2 1-2 miles west of White Oak gap. The coal seam, where it crosses the road, is represented by a band of coal smut, 12 or 15 inches broad.

Near the outcrop is to be seen a small prospect-pit, made some years ago by the New England Company, the owners of the property. The excavation, now well filled with earth, is reported to have exposed a 20-inch coal seam. The rocks in the vicinity of the exposure consist of sandstones and shales, which dip to the west at a low angle.

The several records of bore-holes given below were furnished by Mr. Thos. Cummings, the agent of the New England Company, on

whose property the holes are located:—

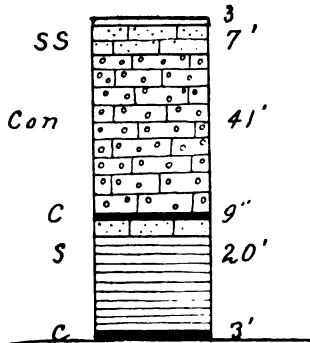
Fig. 39.



RECORD OF BORE-HOLE ON LOT 154, 19TH DISTRICT

1 Surface	1.5 feet
2 Sandstone	8.5 "
3 Conglomerate	25.5 "
4 Coal	0.25 "
5 Conglomerate	8.75 "
6 Shale	28.00 "
7 Coal (good quality)	7.00 "

Fig. 40.

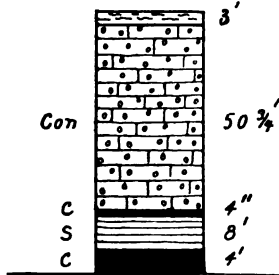


RECORD OF BORE-HOLE ON LOT 147, 19TH DISTRICT

1	Surface	3.00 feet
2	Sandstone	7.00 "
3	Conglomerate	41.00 "
4	Coal	0.75 "
5	Sandstone	4.25 "
6	Shale	20.00 "
7	Coal (good quality)	3.00 "

RECORD OF BORE-HOLE ON LOT 136, 19TH DISTRICT

Fig. 41.



1	Surface	3.00 feet
2	Conglomerate	50.75 "
3	Coal	.25 "
4	Shale	8.00 "
5	Coal (good quality)	4.00 "

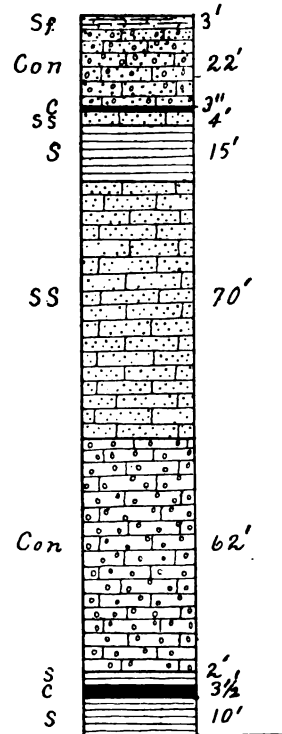
RECORD OF BORE-HOLE ON LOT 139, 19TH DISTRICT

1	Surface	3.00 feet
2	Conglomerate	22.00 "
3	Coal	.25 "
4	Sandstone	4.75 "
5	Shale	15.00 "
6	Sandstone	70.15 "
7	Conglomerate	50.50 "
8	Shale	.30 "
9	Conglomerate	12.00 "
10	Shale	2.00 "
11	Coal (good quality)	3.50 "
12	Shale	10.30 "

RECORD OF BORE-HOLE ON LOT 125, 19TH DISTRICT

1	Surface	5 feet
2	Shale	7 "
3	Coal	1 "

Fig. 42.



4 Shale	9 feet
5 Sandstone	103 "
6 Shale	6 "
7 Sandstone	4 "
8 Shale	129 "
9 Limestone	(?)

The first outcrop of coal on the east side of Sand mountain, north of White Oak gap, is on the New England Company's property, *lot 182, 10th district*. The exposure occurs just beneath the base of a sandstone cliff, near the top of the mountain, only a few rods south of the trail leading from New England City to Cole City. The coal seam, which is exposed in a drift 20 feet long, has a maximum thickness of 22 inches, and

dips northwest at an angle of about 20°.

The outcrop of the seam is about 860 feet above the station at New England City, and about 125 feet above the upper beds of limestone.

At the time of our visit, the drift was partially filled with earth, so that the

following section was made out from the natural exposure :—

1 Massive Sandstone	12 feet
2 Thin-bedded Sandstone	10 "

Fig. 43.

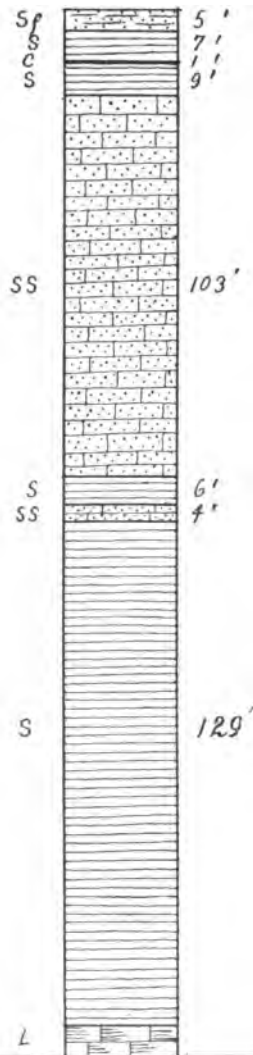
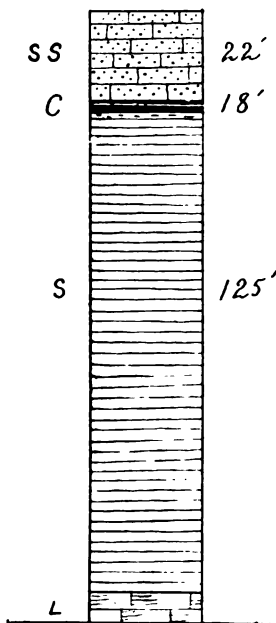


Fig. 44.

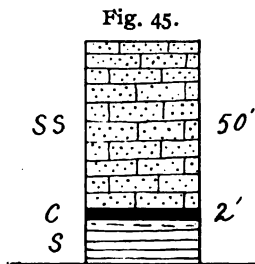


3	Coal	(cliff seam (?))	-----	1 to	4 inches
4	Fire-clay	(" " (?))	-----		7 "
5	Coal	(" " (?))	-----	12 to	18 "
6	Fire-clay	-----			2 feet (?)
7	Shale	-----		125	"
8	Limestone	-----			(?)

The coal, as shown at the entrance to the excavation, is much folded, and is more or less mixed with shale.

THE SPENCER AND BEDOIN PROPERTY

About half-a-mile northwest of the above exposure, on Spencer & Bedoin's property, *lot 181, 10th district*, is another outcrop, of

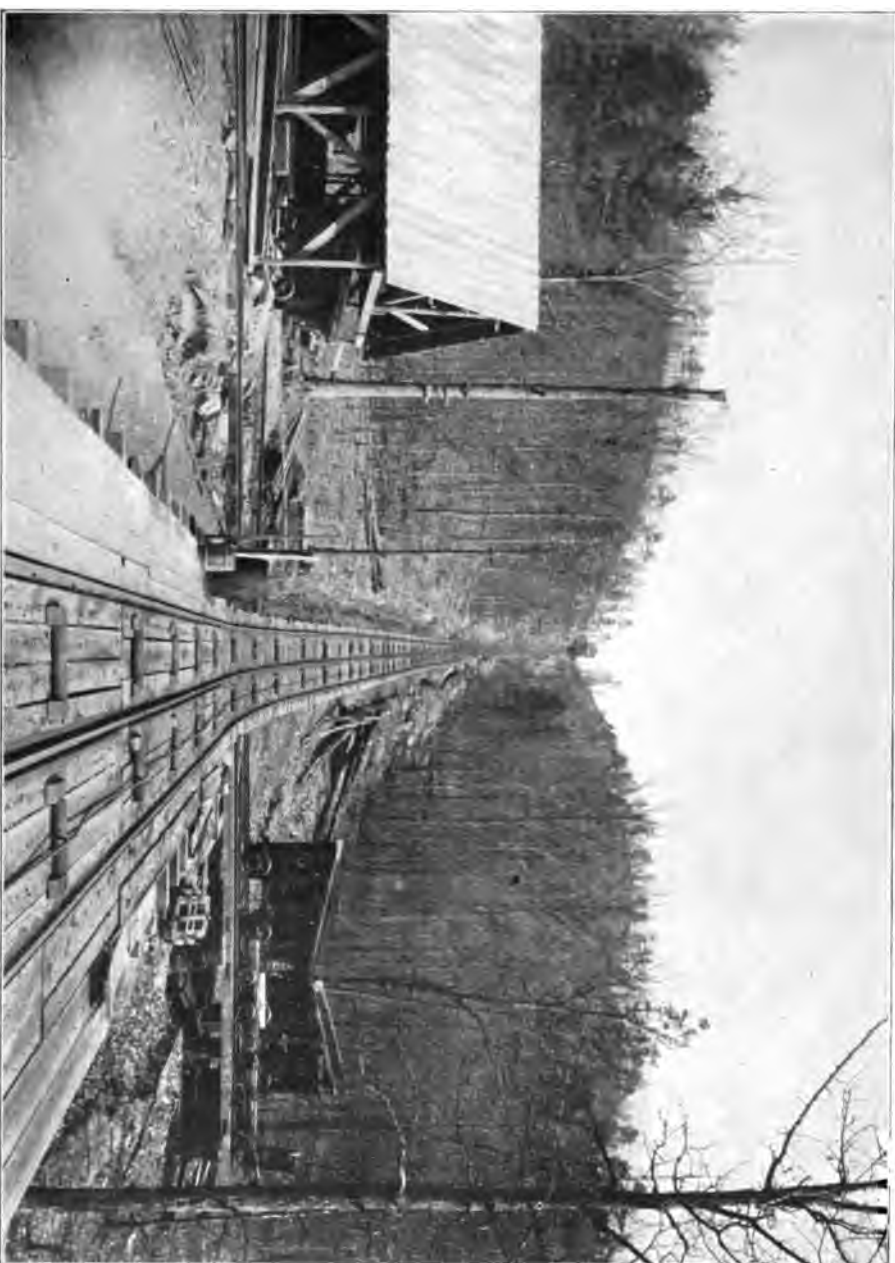


what appears to be the same coal seam. The exposure is a natural outcrop at the base of a sandstone cliff, on the east fork of the Richmond gulch, 800 feet above the station at New England City. The coal seam varies from 6 inches to 2 feet in thickness, and dips at a low angle to the east. The section is as follows: —

1	Massive Sandstone	-----	50 feet
2	Coal	-----	2 "
3	Fire-clay	-----	1 to 2 "
4	Shale	-----	(?)

THE RICHMOND GULCH COAL EXPOSURES

The most extensive outcrop of coal, anywhere to be seen on the east side of Sand mountain, is situated on the New England Company's property, *lot 90, 19th district*. The exposures, which are three in number, are all located on the middle fork of Richmond gulch, about 2 1-2 miles due east of New England City. Two of these exposures are on the west, and one, on the east side, of the gulch, at an elevation of about 50 feet below the coal seam, on lot



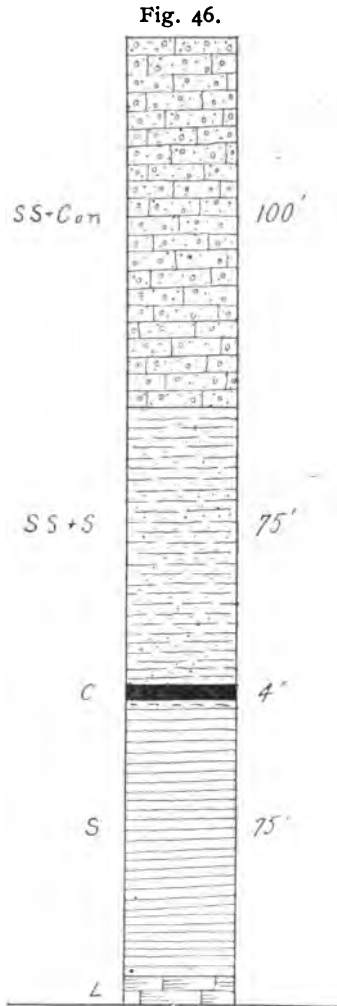
INCLINE RAILWAY, RACCOON COAL MINE, COLE CITY, DADE COUNTY, GEORGIA.

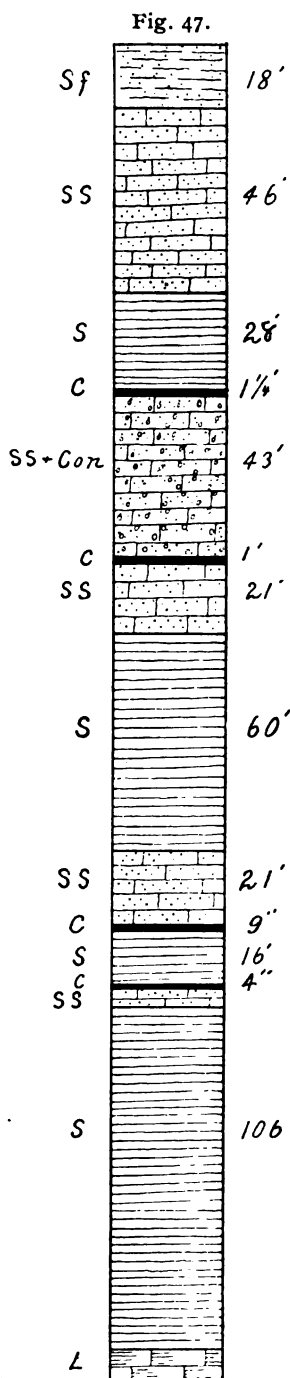


181, just described. The main exposure on the west side of the gulch, consists of a natural outcrop, something like 100 feet long, at the base of a cliff. The coal seam, exposed here, has a maximum thickness of seven feet. At one point, it is parted near its center by a thin layer of hard, bluish, sandstone, which, further along, makes the hanging-wall of the entire seam. The coal is much crushed, and more or less mixed with fragments of shale. The other exposure on the west side of the gulch is to be seen in a drift, something like 100 yards north of the natural outcrop, at the foot of the bluff. The drift is said to be 80 feet long. At the time of our visit, it was flooded with water, and was quite inaccessible. The exposure on the east side of the gulch also occurs in a drift, and was likewise found to be flooded with water and inaccessible. All the exposures on lot 90 are on the same coal seam, a common section of which is here given:—

- | | | |
|---|--|--------------|
| 1 | Heavy-bedded Sandstone forming top of the mountain | 100 feet (?) |
| 2 | Thin-bedded, Shaly Sandstone | 75 " |
| 3 | Coal | 2 to 7 feet |
| 4 | Fire-clay | 2 " (?) |
| 5 | Shales and probably some Sandstone | 75 " |
| 6 | Limestone | (?) |

The rocks, on the west side of the middle fork of the gulch,





seem to dip at a low angle to the west, while, on the east side, they appear to dip at a low angle in the opposite direction.

An analysis of a sample of coal, taken from the above coal seam in 1866, was reported by Prof. James Hall, late State Geologist of New York, to give the following result:—

Fixed Carbon.....	63.9
Volatile Carbon.....	26.8
Ash (reddish).....	9.3
Total	100.0

Another exposure of coal on the New England Company's property, lot 106, 19th district, occurs about half-a-mile west of the above exposure, in a small ravine at an altitude of 800 feet above New England City. Considerable prospecting was done on the lot some years ago; but no coal is now exposed to view, except that lying on the dump.

The following record of a bore-hole put down on this lot gives a complete section, to a depth of a little over 300 feet:—

1 Surface	18.00 feet
2 Sandstone	46.50 "
3 Shale	28.00 "
4 Coal	1.25 "
5 Conglomerate or Sandstone	43.25 "
6 Coal	1.00 "
7 Sandstone	21.50 "
8 Shale	60.50 "
9 Sandstone	21.50 "

10 Coal	-----	.75 feet
11 Shale	-----	16.75 "
12 Coal	-----	.33 "
13 Sandstone	-----	5.66 "
14 Shale	-----	106.00 "
15 Limestone	-----	(?)

W. C. DARBERRY'S PROPERTY

Immediately west of the above exposure, coal is also reported to occur on Mr. W. C. Darberry's property, *lot 123, 19th district*. The point, at which the coal is said to have formerly been exposed, was visited ; but no coal was to be seen *in situ*, on account of the outcrop's being covered by earth washed in from the adjacent hillslopes.

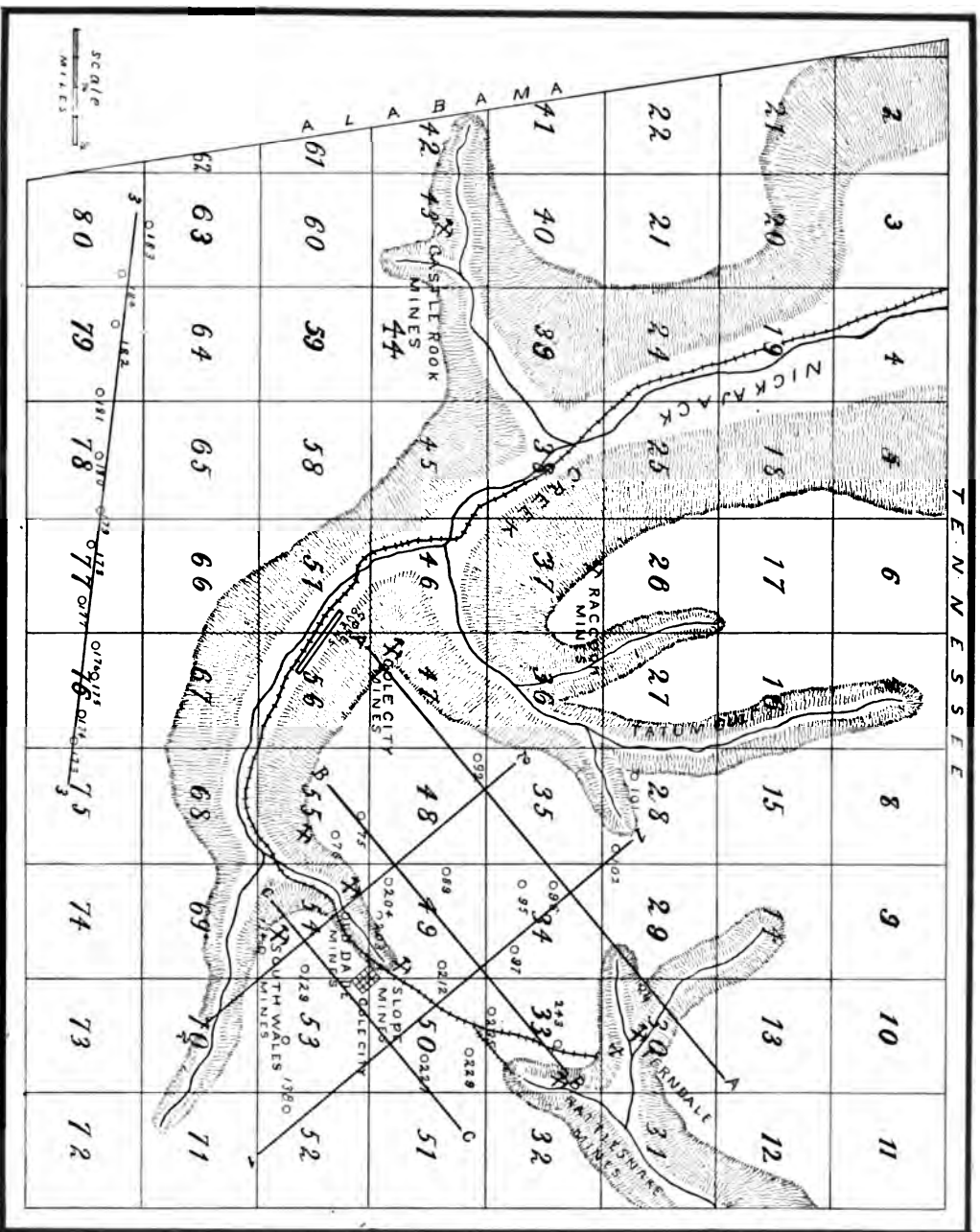
COAL MINES IN THE VICINITY OF COLE CITY

The coal mines in the vicinity of Cole City are located on, or near, the head-waters of Nickajack creek, six miles southeast of Shellmound, Tenn. The location of the mines may be spoken of as being on the west side of Sand mountain, on account of the drainage ; although, geographically speaking, they are located nearer the east side. This is due to Nickajack creek's cutting a deep gulch to the southeast beyond the main axis of the mountain.

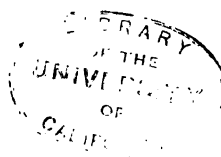
Mining operations were first begun in the vicinity of Cole City, at Castle Rock, by Messrs. Gordon & Russell, more than half-a-century ago, and the coal was hauled by wagon to Shellmound, a distance of something like six miles. The Castle Rock coal mine, probably so called from the castle-like appearance of the cliffs forming the brow of the mountain at that point, is located on the south fork of Nickajack gulch, near the Georgia-Alabama State-line. The mine has been extensively worked, and it has produced large quantities of coal ; but it is now abandoned. Other mines in the vicinity of Cole City, which have been also

more or less extensively worked from time to time, are as follows : The Gordon, the Cole City, the New South Wales, the Elijah, the Rattlesnake, the Pine Mountain, the Ferndale and the Raccoon. The entrance to all the mines here mentioned, with the exception of the Ferndale and the Rattlesnake, are to be seen along the east fork of Nickajack gulch, just beneath the upper sandstone cliffs, that form the brow of the mountain. The Gordon, the Elijah and the New South Wales mines, are each located near the head of the gulch ; while the Cole City, the Pine Mountain and the Raccoon mines are situated on the side of the gulch, a mile or more further to the west. The first three mines, here mentioned, together with the Rattlesnake and the Ferndale, are all connected by spur tracks with the narrow-gauge railroad extending from the top of the mountain to the coke ovens in the gulch. Each of the other mines formerly had inclines, by means of which the coal was lowered to the broad-gauge road in the gulch connecting the coke ovens with the Nashville, Chattanooga & St. Louis R. R. at Shellmound. The Ferndale and the Rattlesnake mines, although connected with the narrow-gauge, as above stated, are located a short distance east of the narrow divide, separating the head-waters of the Nickajack and the Running creeks. The latter creek, which receives the drainage of these mines, flows to the north, and enters the Tennessee river near Whiteside. The entrances to both the Ferndale and Rattlesnake mines are located near each other in the heads of two deep hollows. Each mine is supplied with an incline extending to the top of the mountain, at which point it is connected with the narrow-gauge road leading to the coke ovens.

During my first visit to Cole City, in the summer of 1900, only one of the several mines in the district was being worked. This mine, the Ferndale, gave employment at that time to about 125 miners, chiefly convicts, and produced daily 300 tons of coal. The



Map of the Cole City District, Showing Location of the Various Mines and the Position of Test Bore-holes.



greater part of this coal, after being washed in a sluice box, was manufactured into coke, in the gulch near by, and the remainder was sold to the general trade for steam purposes. In conveying the coal from the mines to the washer, according to the arrangement at that time, the coal cars were run only so far as the margin of the gulch, from whence the coal was conveyed by gravity, in a long shoot extending down the steep slope to the washer. This arrangement reduces the cost of getting the coal off the mountain to a minimum, and at the same time it leaves the coal in good condition for washing; as much of the slate is more or less broken up or loosened from the coal in its transit.

The mining equipment of the Georgia Iron & Coal Company, the present lessee of all the coal mines in the vicinity of Cole City, is quite complete, although some parts of the plant are somewhat out of repair. The equipment, in addition to the 12 or 15 miles of broad- and narrow-gauge railroad, consists of five locomotives; a number of stationary engines and pumps; very complete machine, wood and blacksmith shops; commissaries, office-buildings, numerous miners' cottages, convict barracks, etc. In addition to the above, the company owns 325 coke ovens, 185 of which were in use during the summer of 1900.

It is a difficult matter to obtain any very reliable information as to the aggregate amount of coal taken from the several mines in the Cole City district, from the time of their earliest workings to the present. The only trustworthy information, as far as the writer is able to ascertain, is to be found in the Twentieth Annual Report of the United States Geological Survey, and is as follows:—

Years	Short Tons
1884 -----	150,000
1885 -----	150,000
1886 -----	223,000
1887 -----	313,715
1888 -----	180,000

1889	225,934
1890	225,337
1891	171,000

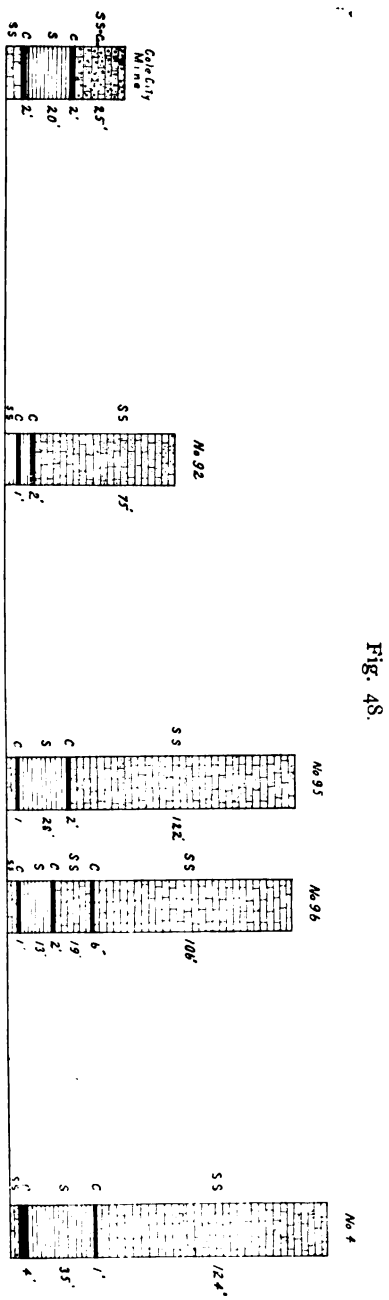
Subsequent to the last date here given, the entire coal output for the State is included in one table in the United States report, so that it is practically impossible to say what proportion of each year's production was the output of the Cole City mines. The mines were worked extensively prior to 1884, under the management of ex-Governor Joseph E. Brown and others; but no record of the output is now obtainable.

The following tables give the approximate date of opening and the date of closing the coal mines in the vicinity of Cole City:—

Name of Mine	When Opened	When Closed
Castle Rock	Not known	1878 (?)
Gordon	Not known	1881
Cole City	1881	1891
New South Wales	1882	1885
Elijah	1884	1892
Rattlesnake	1890	1899
Ferndale	1892	1901
Pine Mountain	1898	1898
Raccoon	1901	Still worked

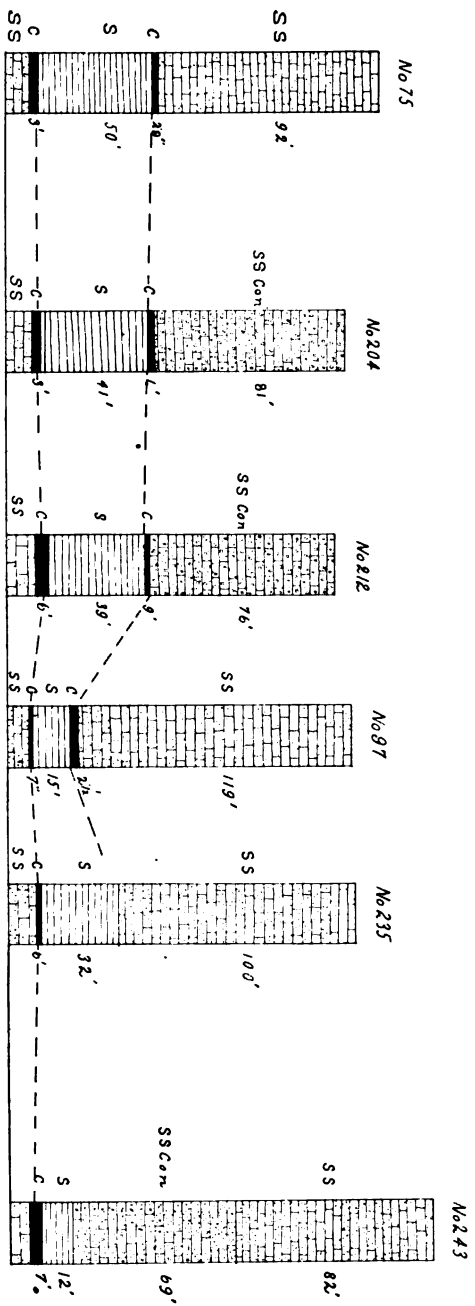
Although the Cole City mine was opened in 1881, it was not worked to any extent until 1891 and 1892. In referring to mines being closed at certain dates in the above table, it is not intended to convey the idea, that the coal seams were entirely exhausted. On the contrary, in most cases, they were closed, to begin work at other points on the same seam, where the coal could be more easily handled. As an example, after the galleries of the Slope mine were driven for many hundred feet to the northwest, it was found advantageous to open up the Ferndale mine, which thereby greatly facilitated drainage and ventilation, and at the same time reduced the underground haul to a minimum.

There are three different workable coal seams in the Cole City



Sections of Bore-holes along the Line A-A on the Map of the Cole City District.

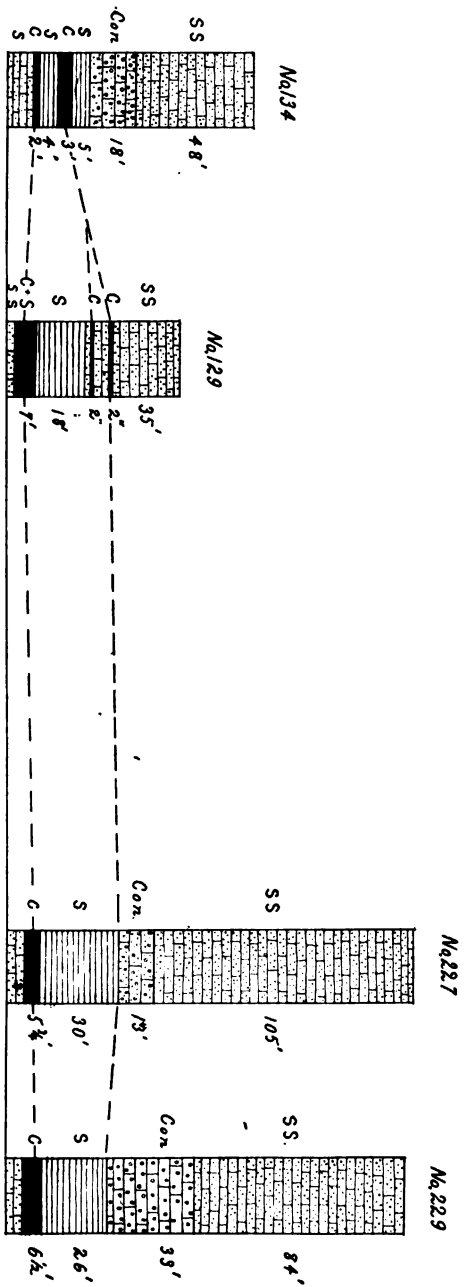
Fig. 49.



Sections of Bore-holes along the Line B-B on the Map of the Cole City District.

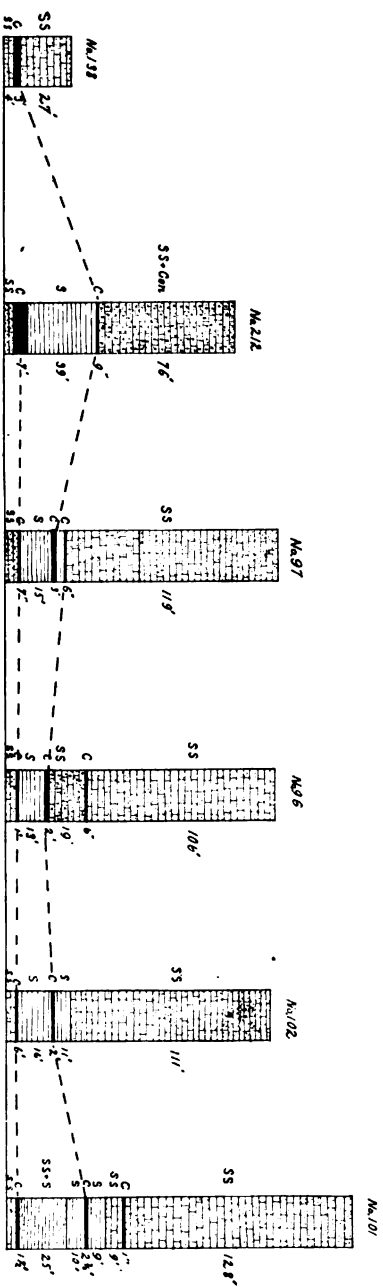


Fig. 50.



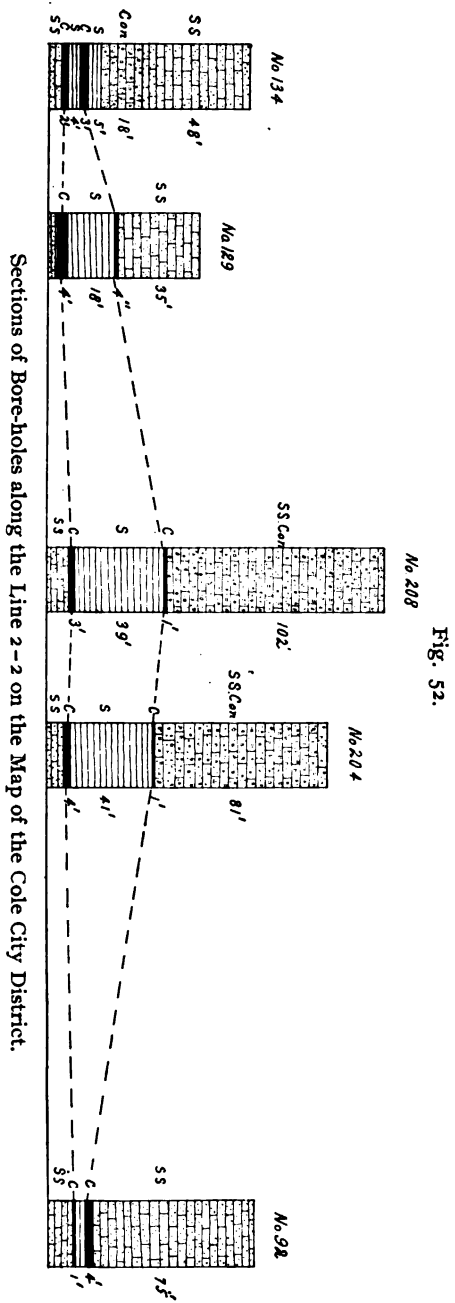
Sections of Bore-holes along the Line C-C on the Map of the Cole City District.

Fig. 51.



Sections of Bore-holes along the Line I-I on the Map of the Cole City District.





Sections of Bore-holes along the Line 2-2 on the Map of the Cole City District.

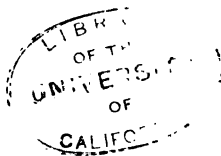
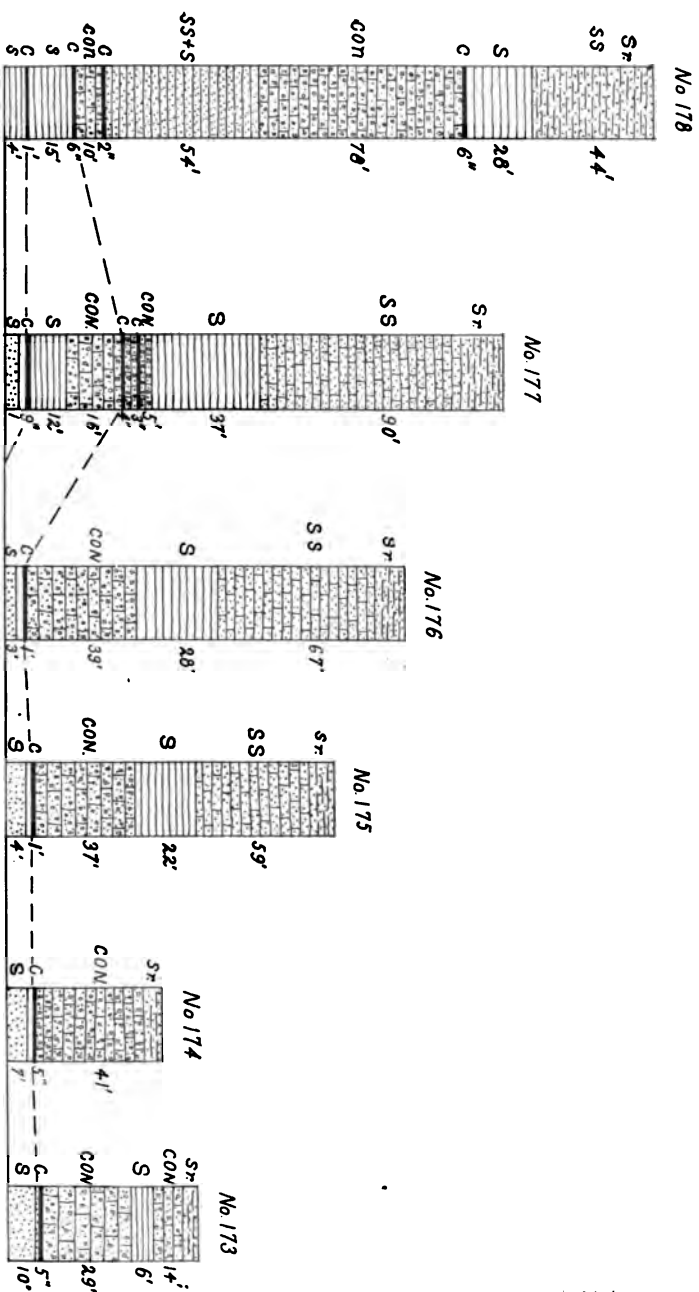
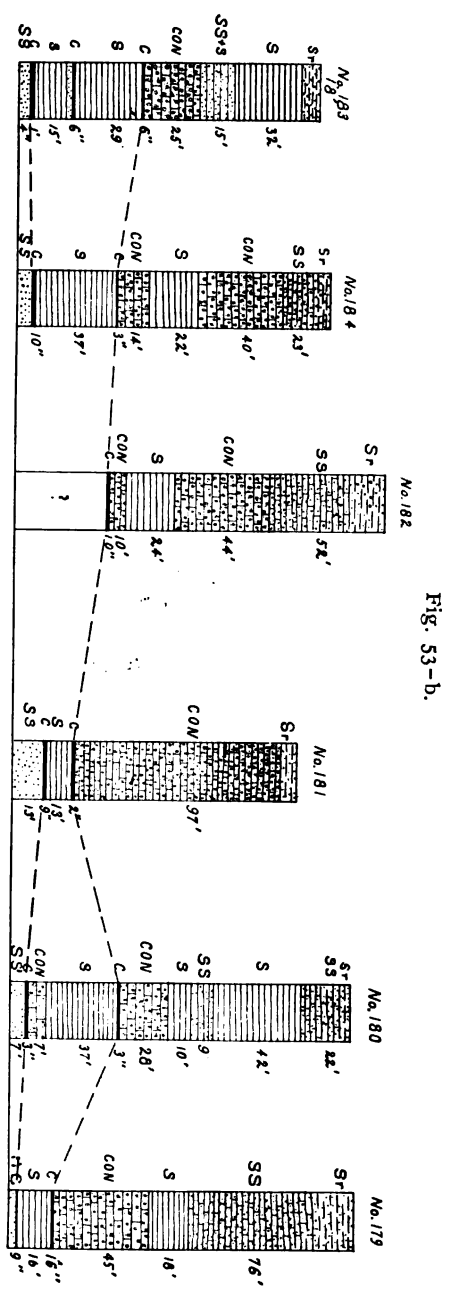


Fig. 53-a.



Sections of Bore-holes along the Line 3-3 on the Map of the Cole City District.



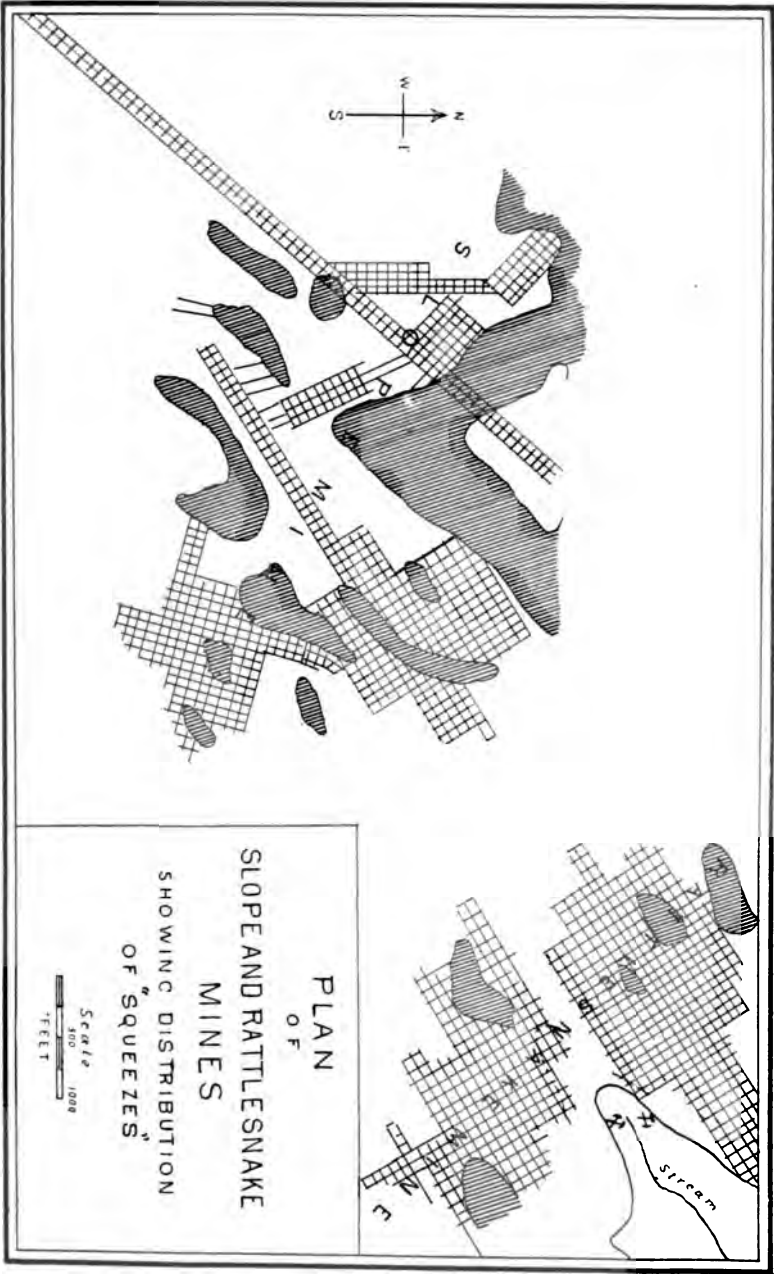


Continuation of Sections of Bore-holes along the Line 3-3 on the Map of the Cole City District.

Fig. 53-b.



Fig. 54.



district, locally known as the Castle Rock or Raccoon, the Dade and the Rattlesnake seams, all of which belong to the Lower Coal Measures. In addition to these seams, there is a fourth seam, known as the Red Ash seam. This seam appears to be quite persistent throughout the district; but, at no point, does it seem to attain sufficient thickness to be worked.

The lowest of the workable coal seams is the Rattlesnake seam, which has been worked to a limited extent at the Rattlesnake and Ferndale mines. This seam varies from 20 inches to 3 feet, or more, in thickness, and is usually divided near its center by a thin parting of shale. The coal often has a columnar structure, and is of good quality.

The Dade coal seam, which has probably produced more coal than both of the other seams together, has an average thickness of about 3 1-2 feet. In some places, this seam is reduced to only a few inches in thickness; while, at others, it attains a thickness of six or eight feet, and even a thickness of 17 feet is reported at one point. The seam is usually divided, near its center, by a layer of shale, varying from a few inches to a foot or more in thickness. The coal, where it has not been crushed, has a laminated structure, and is quite free from shale. The Dade coal seam, like all the other coal seams in the vicinity of Cole City, lies almost level; although, in places, it is subject to small undulations, caused by elevations or depressions in the overlying and underlying strata. These elevations and depressions of the coal seam are supposed by some of the miners to correspond to the hills and hollows on the surface. In some instances, the undulations, above and underground, doubtless correspond; but, as those on the surface are mainly due to surface erosion, it is probable, that such correspondence is more imaginary than real.

The Castle Rock, or Raccoon coal seam, is the upper seam of the Lower Coal Measures, in the Cole City region; and it corre-



LOWER TIPPLE, RACCOON COAL MINE, COLE CITY, DADE COUNTY, GEORGIA.

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sponds to the main *Ætna* seam of the *Ætna* district. This vein is well developed at Castle Rock on the west side of Nickajack gulch, and also at the Raccoon mine on the east side of the gulch, only a short distance north of the Coke ovens. At the latter point, the coal seam is well exposed along the sides of the open-cut leading from the entrance of the mine to the tippie located near by on the brow of the mountain. The coal seam here has a thickness of nearly four feet; but, in the mines, it is said to frequently occur 30 inches or less in thickness. The coal now being mined at the Raccoon mine is reported to be of a very superior quality for coke and steam purposes. Nearly the entire output of the mine, which is at present about 150 tons per day, is being manufactured into coke.

The chemical composition of the coals from the Cole City district is shown by the following analyses taken from Dr. J. W. Spencer's report on the Paleozoic area of Northwest Georgia:—

ANALYSES OF THE DADE COAL SEAM BY DR. GUSTAV BIDTEL

	I	II Old Veins
Fixed Carbon	61.69	74.840
Volatile Matter	27.15	15.860
Ash	10.59	9.310
Sulphur	0.58	1.450
Phosphorus	—	0.059

ANALYSES OF THE REESE RED ASH (RATTLESNAKE SEAM)

	I	II New Veins
Fixed Carbon	66.55	83.22
Volatile Matter	28.64	12.92
Ash	4.41	3.26
Sulphur	1.04	1.05

ANALYSES OF DADE COKE ¹

Ash	Fixed Carbon	Volatile Matter	Phosphorus	Sulphur
26.12	64.98	7.92	—	—
22.91	71.79	5.30	.061	.63
24.74	68.15	7.11	.073	.28
16.73	76.58	6.69	—	—
21.73	69.66	8.42	—	—
20.15	70.48	8.88	—	—

ANALYSIS OF RACCOON UNWASHED, SLACKED COAL, MADE FOR THE GEORGIA IRON & COAL COMPANY BY THE N. P. PRATT LABORATORY, and kindly furnished by Mr. George H. Hurt, General Manager.

Moisture	1.15
Volatile and Combustible Matter	24.85
Fixed Carbon	60.12
Ash	13.88
Sulphur	1.51
Total	101.51

ANALYSIS OF WASHED SLACKED COAL

Moisture	1.17
Volatile and Combustible Matter	27.40
Fixed Carbon	68.49
Ash	2.90
Sulphur	.83
Total	100.79

ANALYSIS OF COKE MADE FROM RACCOON COAL

Moisture	.15
Volatile and Combustible Matter	1.29
Fixed Carbon	93.71
Ash	4.85
Sulphur	.68
Total	100.68

The following section, which was made out from the numerous

¹ Geol. Survey of Georgia, *The Paleozoic Group*, by J. W. Spencer, page 258.

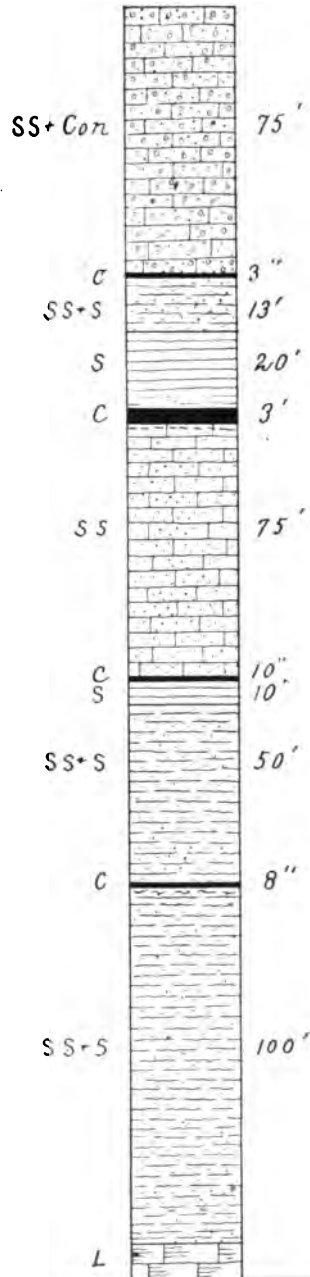
exposures along the narrow-gauge road, between the commissary on the top of the mountain, and the coke-ovens in the gulch, gives a general idea of the entire Coal Measures in the vicinity of Cole City :—

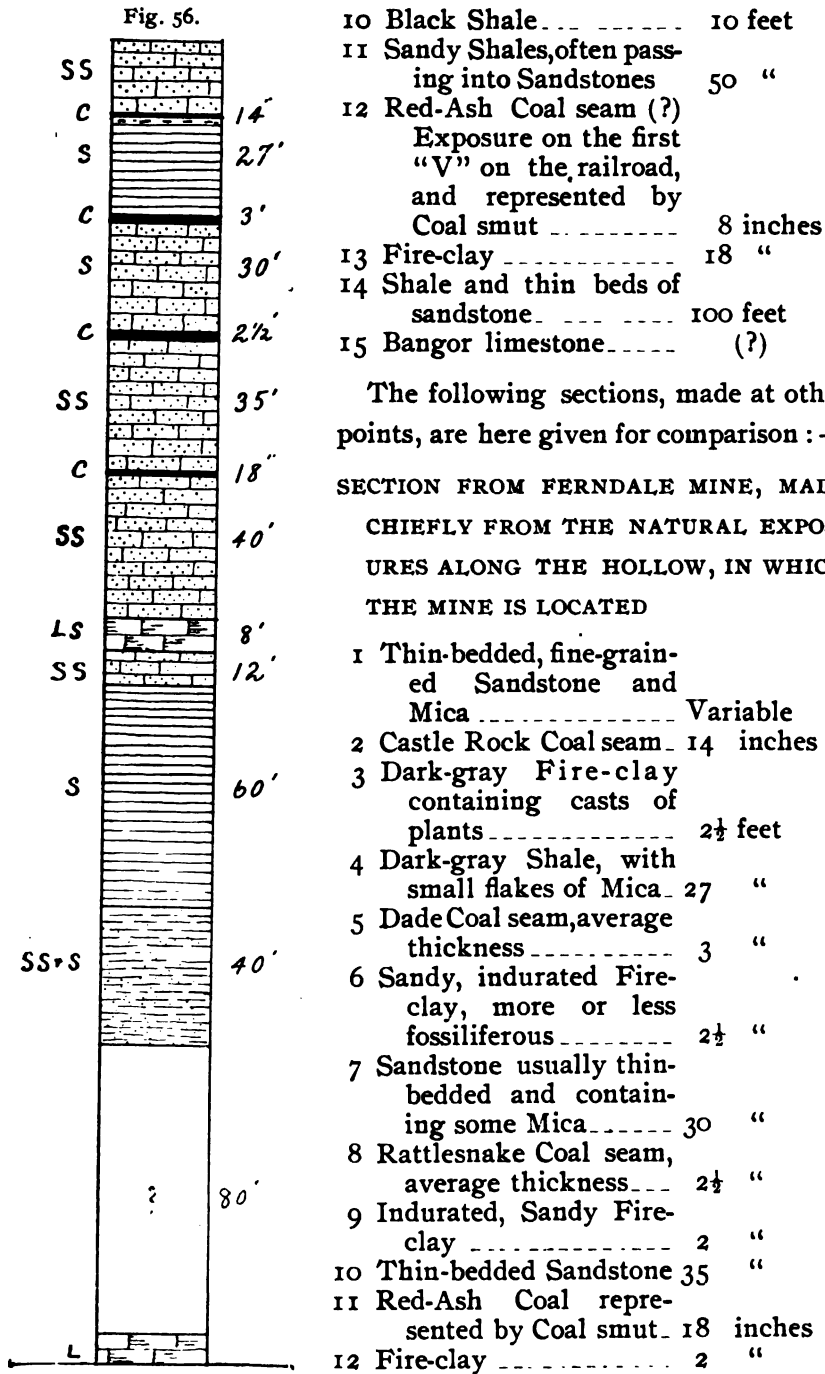
- | | |
|---|----------|
| 1 Sandstone and Conglomerate forming the top of the mountain, the latter often showing numerous casts of plants ----- | 75 feet |
| 2 Castle Rock Coal seam, here referred to----- | 3 inches |
| 3 Gray, Sandy Shale with thin flakes of Mica----- | 10 feet |
| 4 Thin-bedded Sandstone----- | 3 " |
| 5 Black Shale with impressions of ferns etc.----- | 20 " |
| 6 Dade Coal seam with Slate partings----- | 3 " |
| 7 Indurated fossiliferous Fire-clay, Dade bottom----- | 2 " |
| 8 Sandstone, massive in places, but generally partaking of the nature of Sandy Shale. ¹ -- | 75 " |
| 9 Rattlesnake coal seam(?). ² { 6 to 18 inches
{ 3 to 5 feet | |

¹ At some places, the more shaly layers contain traces of Coal, especially where the rock is fractured and much folded. Gentle folds and faults, of a few feet throw, are of common occurrence.

² This coal seam, where first exposed, occurs as one distinct seam, varying from 6 to 18 inches in thickness; but, further down the narrow-gauge road, in the direction of the coke-ovens, it is divided into two seams by a layer of sandstone, from 3 to 5 feet thick. The division of the parted coal seam rarely ever attains a thickness of 10 inches.

Fig. 55.





- 13 Thin-bedded, ripple-
marked Sandstone 40 feet
14 Thin-bedded, partly
crystalline, fossilif-
erous Limestone 8 "
15 Fine-grained, heavy-
bedded Sandstone 12 "
16 Black Shale, partly ex-
posed 60 " (?)
17 Shaly Sandstone, part-
ly concealed 40 " (?)
18 Concealed 80 "
19 Bangor Limestone (?)

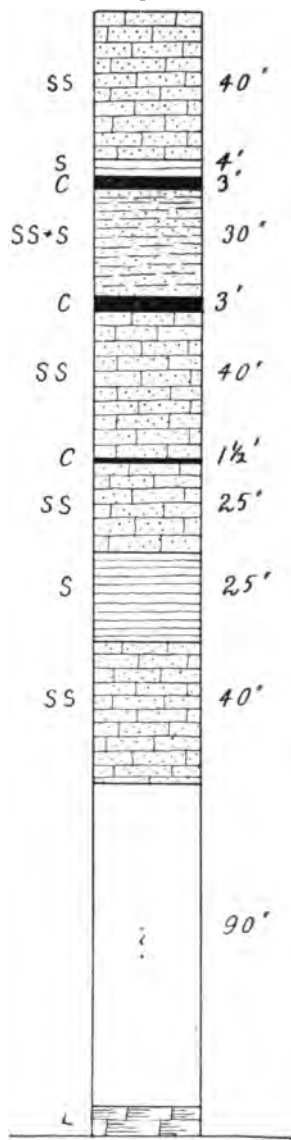
SECTION AT RATTLESNAKE MINE

- 1 Thin-bedded Sandstone 40 feet
2 Black Shale 4 " (?)
3 Dade Coal seam, average
thickness 3 "
4 Fire-clay 2 "
5 Black Shale and thin-bed-
ded Sandstone 30 "
6 Rattlesnake Coal seam 3 "
7 Thin-bedded Sandstone 40 "
8 Red-ash Coal seam 18 inches
9 Sandstone, concealed 25 feet
10 Black Shale 25 " (?)
11 Thin-bedded, Shaly Sand-
stone 40 "
12 Concealed 90 "
13 Bangor Limestone (?)

SECTION AT COLE CITY MINE¹

- 1 Cross-bedded Sandstone
forming top of the
mountain 20 feet (?)
2 Castle Rock Coal seam 12 inches
3 Fire-clay 12 "
4 Sandy Shale 30 feet
5 Dade Coal seam 3 feet
6 Indurated Fire-clay 1½ "
7 Massive Sandstone 20 "

Fig. 57.

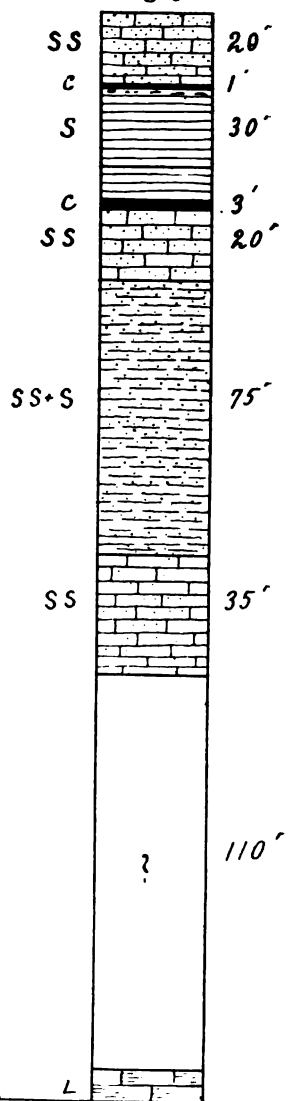
¹ See fig. 58.

8	Sandy Shale with thin beds of Shale	75	feet (?)
9	Massive Sandstone, bluff forming	35	" "
10	Concealed	110	" (?)

SECTION AT CASTLE ROCK MINE MADE
OUT FROM NATURAL EXPOSURE ON
THE SIDE OF THE MOUNTAIN¹

1	Heavy-bedded Con- glomerate	40	feet
2	Castle Rock Coal seam	3½	"
3	Fire-clay	18	inches
4	Sandstone	20	feet
5	Coal	2	inches
6	Sandy Shale, lower bed typical blue shale	75	feet
7	Coal	20	inches
8	Fire-clay	18	"
9	Sandy Shale	60	feet
10	Massive Sandstone	20	"
11	Coal, reported	(?)	

Fig. 58.



In examining the above sections, it will be observed, that there is a marked similarity existing between them; but, at the same time, there is a considerable variation in the thickness of the several strata making up the sections. Take, as an example for comparison, the sections at the Ferndale and the Rattlesnake mines. These are located not over half-a-mile apart; and it would be natural to suppose, that the sections at the two points would be practically the same. Such, however, is not the case. In the first place, it will be noticed, that the Castle Rock coal seam, 14 inches thick at Ferndale, does not occur at all at the

¹ See fig. 59.

Rattlesnake mine. This can not be accounted for, on the grounds of an insufficient exposure; as a bluff at the latter point discloses strata overlying the Dade coal seam, to a thickness of more than 40 feet. In the second place, it will be seen, that the shale, 27 feet thick at the Ferndale, is reduced to 4 feet at the Rattlesnake mine. Furthermore, the black shale lying immediately above the Rattlesnake coal seam in one section is 20 feet thick; while, in the other section, it is only 5 feet. In this case, the distance between the Dade and the Rattlesnake coal seams remains practically unchanged, owing to the shale's being partly replaced by the sandstone. Below the Rattlesnake coal seam, there are other differences in the two sections. However, owing to the imperfect exposure, it is quite likely that some of these are more apparent than real.

Fig. 59.

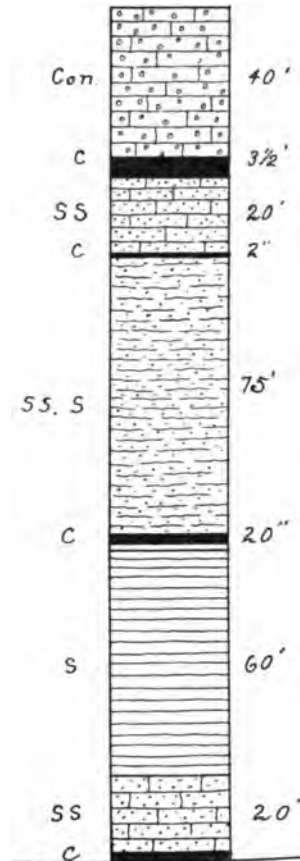
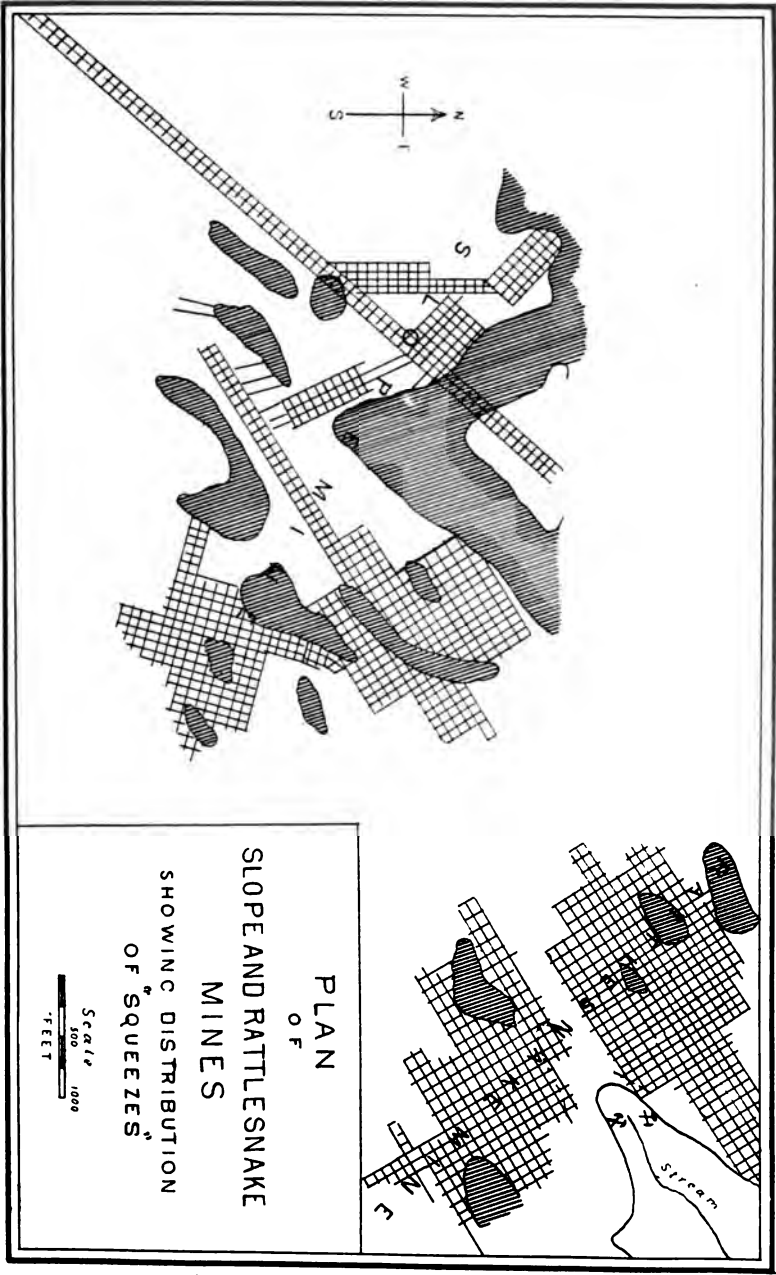




Fig. 54.



False Coal Measures, by geologists; a series of sandstones and shales, with from one to three or four coal horizons. This is an important division of the Coal Measures in Tennessee, and the only one in some regions available as a source of coal. The thickness ranges from a few feet to 300."

The second division, above given, is further divided by Safford into two divisions, namely, the *Upper Conglomerate* and the *Lower Conglomerate*. The latter division, he frequently designates as the *Cliff Rock*, on account of its forming bold cliffs along the eastern margin of the Cumberland plateau. The two conglomerates, above referred to, according to Safford, are generally separated from each other by beds of shales, of variable thickness; but, in some instances, the shales thin out, in which case the two conglomerates coalesce and form a single stratum.

One of the most complete sections of the Coal Measures given by Safford, and one, with which the various coal seams of Georgia may easily be compared, is the *Ætna* section, made from the natural and artificial exposures at the *Ætna* mines, which are located on Sand or Raccoon mountain, only about two miles north of the Georgia-Tennessee State-line.

The section here given, or a similar section made at the same mines by H. E. Colton, late inspector of mines of Tennessee, has been selected by Mr. Henry McCalley, Assistant State Geologist of Alabama, for comparison, in his report on the Coal Measures of the Plateau Region of Alabama. Safford's *Ætna* section, with a few unimportant omissions, is as follows: — ¹

¹ *Geology of Tennessee*, by J. M. Safford, pages 383 and 384.

Upper Measures — 220 feet	(8)	Sandstone, cap-rock of plateau ridge above the Ætna mines.....	75 feet
	(7)	Shale	48 "
	(6)	Coal, "Walker Coal," uniform, good, cubic	4 "
	(5)	Shale, including sometimes a thin coal, (Cravens).....	from 30 feet to 40 "
	(4)	Coal, "Slate Vein," including a layer eighteen inches thick, of Shale and Coal mixed.....	5 to 6 "
	(3)	Shale	44 "
	(2)	Coal, "Kelly Coal"; good cubical coal,	from 2 to 3 "
	(1)	Fire-clay	from 1 to 2 "
	UPPER CONGLOMERATE (simply a sandstone here)....		75 "
	(4)	Coal seam	a few inches
			(3) Shale..... 30 to 40 feet
			(2) Coal seam..... 10 inches
			(1) Sandy Shale..... from 100 to 130 feet

LOWER CONGLOMERATE, *Cliff Rock* of the sections east of the Sequatchee valley, in which it is included in the *Lower Measures*; becomes a well-characterized *Conglomerate*, over the Upper Coal (Main Ætna or Cliff vein) at Gordon's mines in Georgia..... 70 to 100 feet.

Lower Measures (not including Lower Conglomerate). Average — 288 feet	(14)	Shale, sometimes wanting, the rock above making the roof of the coal.....	from 0 to 12 feet
	(13)	Coal, main Ætna or Cliff vein, will average perhaps	3 "
	(12)	Fire-clay, indurated; contains Stigmara, often with rootlets attached	1 to 3 "
	(11)	Shale (?).....	5 to 20 "
	(10)	Coal, thin	$\frac{1}{2}$ to 1 foot
	(9)	Sandstone and Sandy Shale.....	80 to 120 feet
	(8)	Shale	0 to 5 "
	(7)	Coal, of good quality	$\frac{1}{2}$ to 3 "
	(6)	Fire-clay	0 to 2 "
	(5)	Sandy Shale or Sandstone.....	20 to 25 "
	(4)	Shale	15 to 20 "
	(3)	Coal, lowest bed	$\frac{1}{2}$ to 3 "
	(2)	Fire-clay	0 to 3 "
	(1)	Shales and Shaly Sandstones.....	80 to 150 "

MOUNTAIN LIMESTONE FORMATION, consisting of Variegated Shales and Limestones."

THE LOWER COAL MEASURES

That part of the Ætna section including the Lower Conglomerate and the underlying rocks, designated as the Lower Coal Measures, is very similar to the general section made out along the gulch in the vicinity of Cole City.¹ In these two sections, not only the same number of coal seams are to be seen, occupying the same relative position; but the intervening strata are quite similar, both in character and thickness. The Castle Rock seam in the Cole City district, as may be seen, corresponds to the Ætna seam of the Ætna district; while the Dade, Rattlesnake and Red-ash seams are represented by the three lower seams of the Ætna section. In support of the correctness of this correlation, it may be pointed out, that the coals of the Ætna and the Castle Rock seams are very much alike in physical structure, as well as in chemical composition, a proof going to show, that, if the two seams are not continuous, there was at least a remarkable similarity in conditions prevailing during the time of their deposition. That part of the Ætna section, above the Lower Conglomerate, is entirely wanting in the Cole City section. However, these upper sandstones and shales, together with their associated coals, occur only a short distance south of Nickajack creek gorge.²

Dr. J. W. Spencer, formerly State Geologist of Georgia, in speaking of the coal seams in the Cole City district, says:—³ "The highest of these seams below the Lower Conglomerate appears to be the Ætna bed of Sand mountain, situated on an insular plateau between the Georgia line and the Tennessee river. The section at Ætna and Cole City, below the Lower Conglomer-

¹ See fig. 55, page 91.

² See section No. 178, fig. 53-a.

³ Geological Survey of Georgia, *The Paleozoic Group*, by J. W. Spencer, page 249.

ate have about equal thickness, and each contains four known coal seams.''

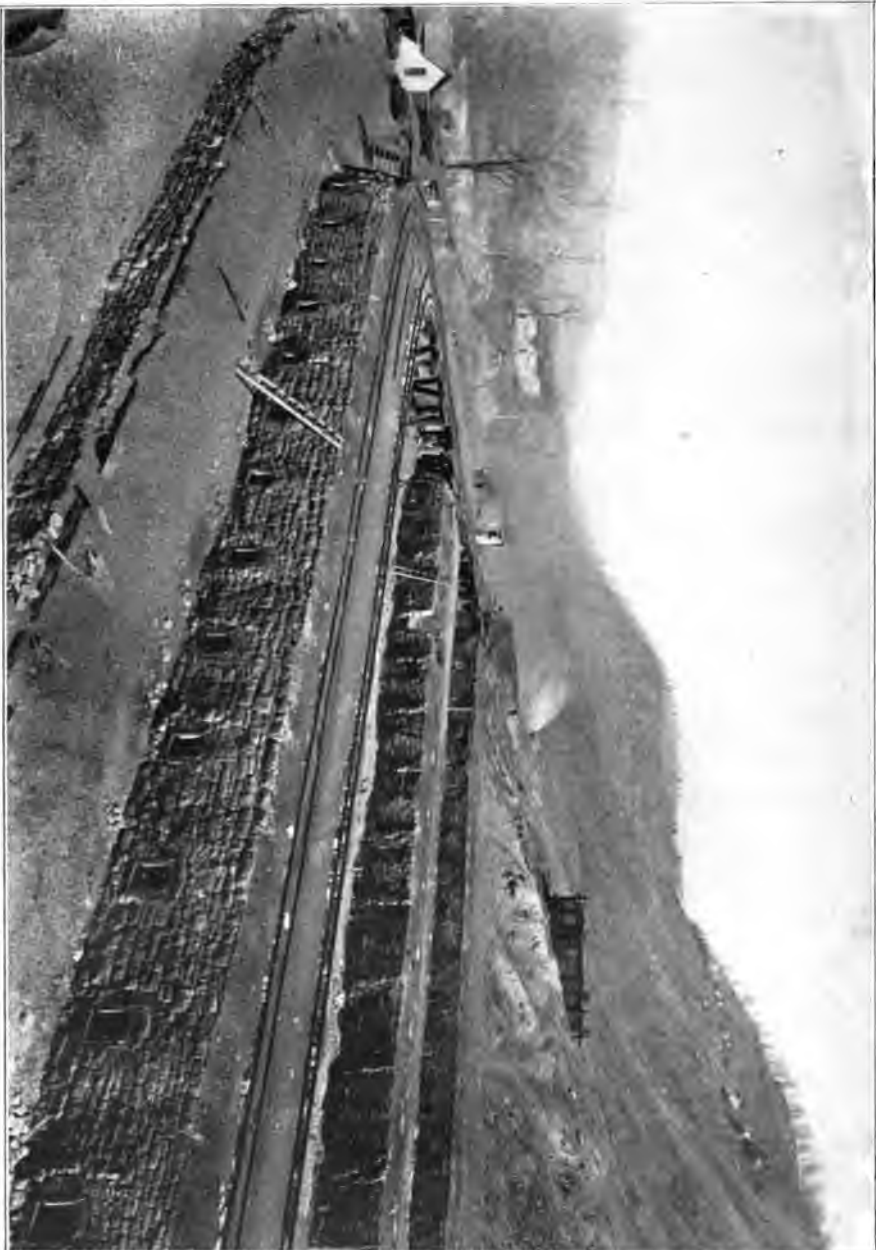
In McCalley's section of the coal measures in the Cole City district, the Castle Rock seam, or what he terms the Cliff seam, is correlated with the Ætna seam, which lies immediately below the Lower Conglomerate.¹ He finds the Cliff, or the Castle Rock seam, exposed at many points along the west side of Sand mountain, in Alabama, south of Nickajack creek. In the neighborhood of Long Island creek, where the Lower Conglomerate has a thickness of nearly 100 feet, he reports exposures of the Cliff vein, varying from 1 to 3 feet in thickness. In the same vicinity, he notes the occurrence of a second coal seam overlying the Lower Conglomerate, which he correlates with the Sewanee seam of Colton's Ætna section.

On the east side of Sand mountain, between Brown gap and the Georgia-Alabama State-line, and also on the west side of Fox mountain, McCalley found the Cliff vein exposed at several points just below the Lower Conglomerate.² A further examination of McCalley's report shows, that the Cliff vein is frequently exposed along both sides of Lookout mountain, near the Georgia-Alabama State-line, and is one of the most persistent coal seams of northeastern Alabama.

The section of the Coal Measures, in the Stephenson Geologic Folio, of the Cole City district, by Dr. C. W. Hayes, is practically the same as my Cole City section. However, the distance between the lower coal seam in his section, and the Bangor Limestone, is greater by more than 100 feet, than is shown in my section. This difference in measurement probably originates from what may be considered the upper beds of the Bangor Limestone. In my section, the first thin beds of limestone, interlaminated with the beds

¹ Coal Measures of the Plateau Region of Ala., page 44.

² *Ibid.*, page 83.



COKE OVENS OF THE GEORGIA IRON AND COAL COMPANY, COLE CITY, DADE COUNTY, GEORGIA.



of shale below the sandstones, are supposed to represent the upper beds of the Bangor Limestone ; whereas, Hayes probably considers the heavy-bedded limestone, many feet below, the upper beds of the formation. In Hayes's section it will further be noticed, that there is a coal seam shown below the Red-Ash seam, not appearing in my section. This exposure of coal actually occurs as represented in Hayes's section ; but, from a careful examination of the exposure, I was led to believe, that the coal was not in place, being a slide from some of the seams above ; and, as a consequence, it does not appear at all in my section.

It is quite evident, that, at some points on Sand mountain, there undoubtedly occurs one or more coal seams below the Red Ash. Nevertheless, I question its general presence in the Cole City district. Colton in his section of the *Ætna Coal Measures*, gives five coal seams below the Lower Conglomerate.¹ This would indicate, that the coal seam below the Red Ash, may have a considerable extension to the north.

In this connection, it might be well to note, that Hayes's section at the *Ætna mines*² shows only three coal seams below the Lower Conglomerate, the lowest of which he designates as the Dade seam, and the upper, the Castle Rock ; while the intervening one receives no name whatever. It is difficult to understand why the lowest seam in this section, should be correlated with the Dade seam, when the middle vein, as shown by its overlying shale, is unquestionably the true Dade seam. The coal, designated by Hayes as the Dade seam in his correlation, seems to correspond to what is called the Rattlesnake or Reese seam of the Cole City district. With the difference here pointed out, together with the absence of a fourth coal seam, which I have correlated

¹ *Coal Measures of the Plateau Region of Ala.*, page 18.

² *Geologic Atlas, Ringgold Folio*, U. S. Geol. Surv.

above with the Red Ash seam, Hayes's section corresponds very closely with the Safford section at the *Ætna* mines.

In attempting to correlate the coal seams on the east side of Sand mountain with the coal seams in the Cole City district, considerable difficulty is encountered. This is due chiefly to the limited natural exposures and the meagre data obtainable from the few bore-holes put down near the east brow of the mountain. The records of the borings, in many instances, are very unsatisfactory on account of the descriptive terms used to describe the rock penetrated. Terms often occur in these records, that have no definite meaning, such as "Silicate Rock"; and again, entirely dissimilar rocks are sometimes designated by the same name. Such data are not always easy to interpret; yet, in nearly all cases, the records of borings are sufficient to give a general idea of the nature of the formations penetrated.

Before attempting to correlate the coal seams of the Cole City district with the coal on the east side of Sand mountain, it may be well to examine first, in detail, the various sections of the Cole City district, as revealed by the numerous bore-holes put down in that section. By referring to the map of this district, it will be observed, that the sections of the bore-holes along the lines C-D and E-F show, that the Castle Rock seam thins out, or entirely disappears, in passing toward the east side of Sand mountain; while the sections along lines 1—2 and 3—4, on the same map, show its extension both to the north and to the south. This would seem to indicate, that the Castle Rock seam has a limited eastern extension, and that it is probably entirely wanting on the east side of Sand mountain. The northern and the southern extension of the seam beyond the limit of the State, on the other hand, appears to be well established, as is above pointed out in the reports of Safford and McCalley; yet no conclusive evidence, as far as the

writer has been able to ascertain, is to be had, to demonstrate that the seam has, at the same time, a far-reaching eastern extension.

Safford, in his section made out at the Point on Lookout overlooking Chattanooga, reports the occurrence of only one coal seam below the Conglomerate.¹ No attempt is made by him, however, to correlate this coal, the existence of which he even seems to question, with the coal of the *Ætna* section. Hayes, in his section of the Coal Measures in Johnson crook, Lookout mountain, likewise gives one coal seam below the Lower Conglomerate;² but no suggestion is made as to its representative, either in the Cole City or the *Ætna* districts. There is no question, as to a coal seam's underlying the Lower Conglomerate, both in Sand and Lookout mountains; yet there are grave doubts as to what seam it actually represents. The seam is undoubtedly the Castle Rock, or the Dade seam; but, as to which it represents, the data at hand do not seem to be sufficient to warrant a definite conclusion.

The difficulty in correlating the main coal seams below the Lower Conglomerate of Lookout mountain and the east side of Sand mountain, with the Dade or Castle Rock seams, will be readily understood by a further examination of the sections in the Cole City district. It will be noticed, in these several sections, that the Castle Rock seam, in nearly all cases, lies immediately beneath the Lower Conglomerate; and, in turn, it is underlain by shales of very variable thickness. The stratum of shale, which separates the Castle Rock from the Dade seam at some points, attains a thickness of more than 50 feet; while, at other points, it is reduced to only 2 or 3 feet. In working the Dade seam at the Cole City mine, this shale was found to be so reduced in thickness as to form a mere parting between the two seams. This condition occurs, also, in the vicinity of the South Wales mine.³ In the

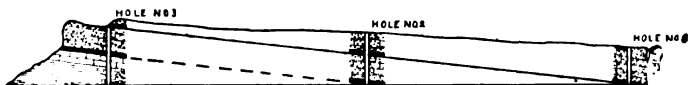
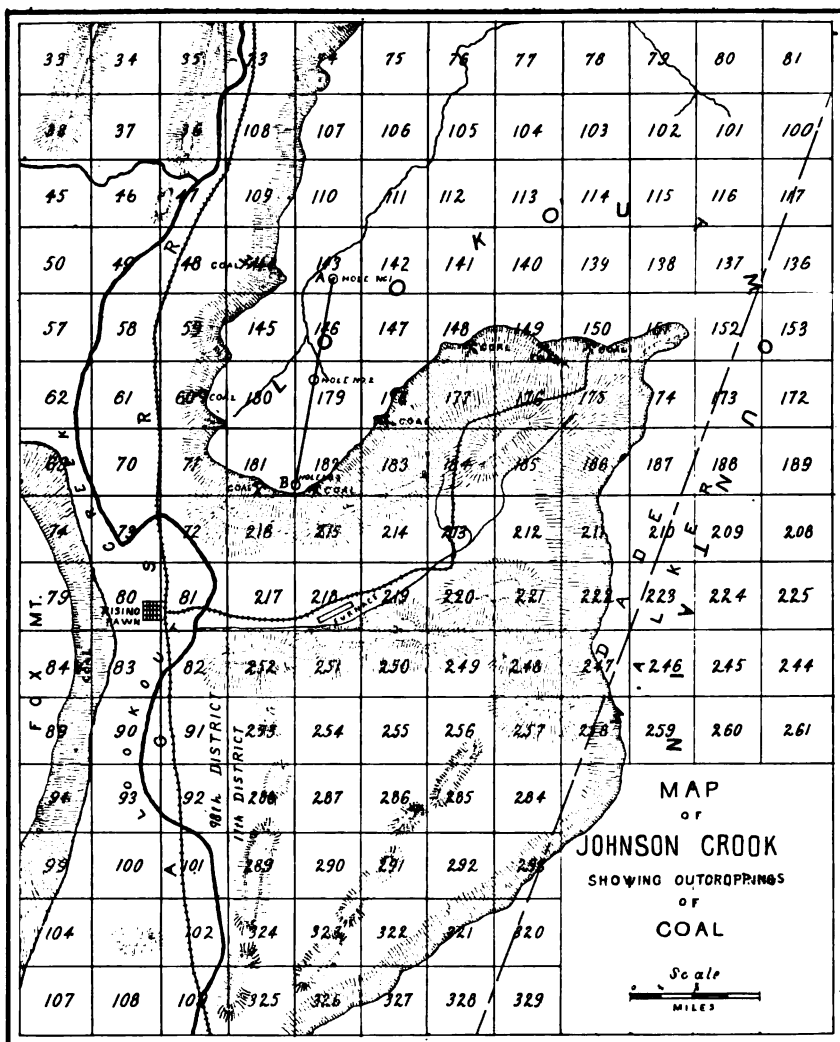
¹ *Geology of Tennessee*, page 385.

² *Geologic Atlas, Ringgold Folio*, U. S. Geol. Survey.

³ See section of bore-hole No. 134, fig. 52.

last named instance, it will be observed, that there is found, between the conglomerate and the Castle Rock seam, a stratum of shale five feet in thickness, thus bringing the Dade seam within 10 or 12 feet of the conglomerate. In this case, suppose that one of the seams should thin out, or disappear, as is evidently the case with the Castle Rock seam only a short distance further to the northwest, shown by borings Nos. 227 and 229, fig. 50; what data would the prospector have at hand for identifying the seams? He would hardly be justified in calling it either the Castle Rock or the Dade seam; as the evidence is by no means conclusive. As an illustration of the point in question, take the White Oak Gap section, located on the east side of Sand mountain near Trenton. Here, we have a coal seam below the Lower Conglomerate, but separated from it by an intervening layer of shale, 12 feet in thickness. Similar sections are to be seen on the east side of Fox mountain, and on the west side of Lookout, in Johnson creek.

It might be suggested, that the chemical and the physical properties of the coal, or the underlying strata, would throw some light on this question. As to the chemical and physical properties of the coal found below the Lower Conglomerate on the east side of Sand mountain, and on the west side of Lookout mountain, it might be stated, that neither of these properties has been sufficiently investigated to give any definite data as to the identification of the coal. The seams, in most places where they are exposed, are so much weathered and broken down, that they show but imperfectly the original structure; and, in only a few instances, have analyses been made. The analyses at hand often show a greater variation in the chemical composition of specimens taken from the same seam, than they do in that of specimens taken from different veins; so that the analyses are practically worthless as a means of correlation. On the other hand, the char-





acter of the underlying strata, which would naturally be supposed to aid in identification, furnishes no conclusive evidence as to their identity. This is well illustrated, in the various sections given on the east side of Fox mountain and the west side of Lookout. In some instances, as may be seen from these sections, sandstone underlies the coal seam located immediately below the Lower Conglomerate; while, in other instances, it is underlain by shales. It is true, that the shale, in most cases, is only a few feet in thickness. Nevertheless, its presence would indicate, that the overlying coal is the Castle Rock seam, while the Dade seam is wanting. In other cases, where the sandstone is the underlying rock, we may, with equal propriety, call the coal the Dade seam, and say that the Castle Rock seam is absent. In view of the facts above stated, the writer is of the opinion, that it is at present practically impossible to correlate the coal below the Lower Conglomerate of the east side of Sand and the west side of Lookout mountains, with the seams of the Cole City district. This being true, it is thought advisable to designate the coal immediately below the Lower Conglomerate as the "*Cliff seam*," a term first introduced by Safford, and afterwards adopted by McCalley, to designate a coal seam occupying the same relative position in the Coal Measures of Tennessee and Alabama.

The coal seams lying below the Dade seam in the Cole City district, namely, the Rattlesnake and the Red Ash, appear to entirely thin out, before reaching the eastern brow of Sand mountain. There is, however, evidence of one of these seams to be seen at White Oak gap. The exposure here, which consists of a narrow band of coal smut crossing the public road, occurs some 75 or 100 feet below the Cliff seam. With this exception, there seems to be no evidence of coal below the Cliff seam, either on the east side of Sand, or the west side of Lookout mountain. It was the general opinion, some years ago, that these lower coal seams could be

located on the eastern slope of Lookout mountain in the vicinity of High Point, near Johnson crook, and along the slope of Lookout, north of this point ; but prospecting at these places was unsuccessful in demonstrating their presence.

McCalley reports the occurrence of two or three coal seams below the Cliff seam, at several points in Alabama, both on Lookout and Sand mountains. The seams are, however, small, and are of little or no commercial importance. The presence of coal seams underlying the Cliff seam is demonstrated by a bore-hole on *lot 106*, located on Sand mountain, about two miles west of its eastern brow. It is also likely, that the exposure of coal on *lot 90*, Richmond gulch, is one of the lower coal seams ; but, further to the east, it is quite probable, that these lower coal seams are entirely wanting.

COAL BETWEEN THE UPPER AND THE LOWER CONGLOMERATE

The coal seams, which occur in Safford's section of the *Ætna* district, between the Upper and the Lower Conglomerate, appear to be entirely wanting in the vicinity of Cole City ; but, only a short distance south of this district, as previously pointed out, coal occurs between these conglomerates. McCalley,¹ in following out the nomenclature of Colton, in his *Ætna* section, calls one of these seams "the Sewanee seam," a name applied by Safford to the main seam in the Sewanee district, overlying the Upper Conglomerate, and which, therefore, belongs to the Upper Coal Measures. The seam here, erroneously designated by McCalley as the "Sewanee seam," seems to be a coal seam of considerable extent and of some economic importance. It probably underlies all of Lookout mountain and a large part of Sand mountain, south of Cole City. This coal is thought to have been penetrated, as heretofore noted, by some of the bore-holes located on Sand mountain, a short distance

¹ Coal Measures of the Plateau Region of Ala., page 46.

south of Cole City, and also by the borings on the New England Company's property, to the southeast of Cole City. Safford, in his section of Lookout mountain at the Point Hotel, notes the occurrence of this seam just below the Upper Conglomerate; but it seems to have been entirely overlooked by Hayes; as it does not occur at all in his section of the Coal Measures made out at Johnson crook, a point, at which the seam appears to reach its greatest development. This coal seam, which, in the last two or three years, has been prospected to a considerable extent along the brow of Lookout to the north of Johnson crook has a thickness varying from 24 to 48 inches. On the east side of Lookout mountain, this coal seam is also exposed at several points, both north and south of the Georgia-Alabama State-line. It may be seen on the Bryan property, near Stephen gap; and it also occurs in the Guyton gulch, about 2 1-2 miles northwest of Menlo. McCalley records the occurrence of this seam at a number of points along the east side of Lookout mountain, only a short distance south of Menlo, and also on the west side of the mountain in the vicinity of Fort Payne. His section at the Fort Payne Coal & Iron Company's mines shows the seam, which he designates as the "Sewanee Seam," to attain a maximum thickness of 3 1-2 feet; while, at other points, he found its thickness to vary from 8 to 12 inches. The persistence of this coal over a large area, both in Georgia and in Alabama, would seem to entitle it to a definite name. The name given it by McCalley in his report of the Coal Measures of the Plateau Region of Alabama is objectionable, as previously pointed out, on account of this name having been given originally to an entirely different seam, occurring in the Upper Coal Measures as defined by Safford. It has been suggested, that this seam might be designated as the *Upper Cliff Seam* on account of its usually occurring at the base of the second sandstone cliff, encountered in ascending either Sand or Lookout mountains. The name "Upper

Cliff Seam" appears to be well chosen, as it is somewhat descriptive; and, having no more appropriate name at hand, the writer has adopted it in this report as a substitute for the "Sewanee Seam," as used by McCalley; while the latter name will be used as originally employed by Safford to designate the main Sewanee coal seam of the Upper Conglomerate.

THE UPPER COAL MEASURES

The Upper Coal Measures of Safford seem to be poorly represented on that part of Sand mountain lying within the limits of Georgia. Dr. Spencer, in speaking of the Coal Measures of the Cole City district, says:—¹ "The Upper plateau ridge of Sand mountain is limited to a small area, owing to the extreme denudations, leaving the Upper Conglomerate of the Castle Rock region most commonly forming the margin of the table-land of Sand mountain; but even this conglomerate is wanting in places on the east side of the mountain." Between Cole City and the Georgia-Tennessee State-line, Spencer notes the occurrence of 300 feet of sandstone and shale, with one coal seam above the Upper Conglomerate. Hayes maps a considerable area between Cole City and the Georgia-Alabama State-line, and also three small areas north of Cole City, as Walden sandstone; and, in discussing the probability of coal's occurring in the formation, he says:—² "The Walden sandstone in this area has not been sufficiently prospected for coal, to justify definite statements concerning it; but, a short distance to the northwest, at *Ætna*, shown on the Chattanooga sheet, these Upper Coals are extensively worked." No record is made by McCalley, of these upper coal seams occurring on Sand mountain in Alabama, near the State-line; but he points out their occurrence on the same mountain further to the south.

¹ Geol. Survey of Georgia, *The Paleozoic Group*, by J. W. Spencer, 1893, page 250.

² Geologic Atlas, Stevenson Folio, U. S. Geol. Surv.

The meagre remnants of the Upper Coal Measures of Sand mountain form a marked contrast with the Upper Coal Measures of Lookout mountain. This contrast is especially marked, when the comparison is made in the vicinity of the Durham coal mines, where the Upper Coal Measures, according to the writer's estimate, has a maximum thickness of more than 800 feet. The Upper Coal Measures at this point, it will be noticed, has no less than six coal seams, two or more of which are workable.

No attempt, so far, seems to have been made, to correlate these various coal seams with the coal of the Upper Coal Measures of Alabama and Tennessee. Safford refers to several workable coal seams on Lookout mountain south of the Georgia-Tennessee State-line; but he makes no attempt whatever to show their stratigraphical relation to the coal seams of Tennessee. In McCalley's general section of Lookout mountain in Alabama, he gives three different coal seams above the Upper Conglomerate, which he attempts to correlate with the coal of Colton's *Ætna* section. The Upper coal seams are found by McCalley to be best developed near the southern end of the mountain, and are partially, or entirely wanting near the Georgia-Tennessee State-line. The most extensive notes, to be found anywhere on the Upper Coal Measures of Lookout mountain in Georgia, occur in Spencer's Paleozoic Group of Georgia. In speaking of these Measures, he says: — "It may be noted that all of these coal seams in the following section are in a horizon above the Upper Conglomerate, and therefore above the Castle Rock seam. The coal in the vicinity of Cole City is, geologically, lower, but at the same time at a higher horizon than the *Ætna* coal fields in Tennessee." The section to which Spencer above refers, is here given.

SECTION OF LOOKOUT MOUNTAIN ALONG ROUND MOUNTAIN AND
CHICKAMAUGA RAILROAD

1 Laminated Shales with a few layers of sandstone on Round mountain (partly concealed)	200.00 feet
2 Shale (concealed)	65.00 "
3 Shale	9.00 "
4 Coal and Shale intimately laminated	14.00 "
5 Shale and Sandy Shale partly concealed	25.00 "
6 Coal	0.70 "
7 Shale	18.00 "
8 Sandstone, gray, laminated	35.00 "
9 Coal, Durham seam, worked	4.00 "
10 Sandstone, irregularly and often thinly-bedded and undulating	80.00 "
11 Red Shale	11.00 "
12 Black Shale	4.00 "
13 Shale and Sandy Shale with seams of Limestone	10.00 "
14 Blue Shale above and variegated Shale below	7.00 "
15 Coal	1.83 "
16 Thin laminated blue Shale	70.00 "
17 Red Shale	35.00 "
18 Coal	0.20 "
19 Light Blue Clay	2.00 "
20 Shales and Sandy Shales passing into Sandstone	150.00 "
21 Coal	1.66 "
22 Sandy Shale. 1 to	3.00 "
23 Heavy-bedded Sandstone	25.00 "
24 Upper Conglomerate and Sandstone forming Eagle Cliff	150.00 "

This section, it will be noticed, gives seven different coal seams, all of which belong to the Upper Coal Measures. No effort is made by Spencer, in any part of his report, to correlate these coal seams with the seams of the Upper Coal Measures elsewhere.

Haves, in his section at the Durham mines, gives only two coal seams above the conglomerate. ¹ One of these seams, whose thick-

¹ U. S. Geol. Atlas Kinggold Folio U. S. Geol. Surv.

ness, together with its associated shales, he places at 11 2-3 feet, is probably the Durham seam, now being worked, although its average thickness is less than four feet. The other seam, represented in his section, lies some 80 feet above the 11 2-3-foot seam. This coal, together with its slaty partings, he estimates at 4 feet in thickness.

According to Hayes's section at the Ætna mines, given in the Ringgold Folio, the coal seams at the Durham mines lie from 275 to 350 feet above the upper coal seam at the Ætna mines. It is not stated by him, whether this difference is due to the great thickness of the underlying sandstones and shales in Lookout mountain, or to the occurrence of the coal at the Durham mines in the higher strata of the Upper Coal Measures. The only suggestion given by him as to the correlation of the coal seams, which he gives in his Durham mines section, is as follows:— "They very nearly correspond in position with the coal, which is worked further north in the Walden, at the Dayton and Rockwood mines." As the main coal seam at Dayton lies about 650 feet above the conglomerate, it is taken for granted, that Hayes places the coals of his Durham mines section at a higher horizon, geologically speaking, than the upper coal seams at the Ætna mines.

In comparing my general section of the Upper Coal Measures of Lookout mountain, made out along the Durham & Chickamauga railroad, with Safford's Ætna section, it would seem, that an effort to correlate the different coal seams of the two sections would be a hopeless undertaking. In the first place, it will be observed, that these measures on Lookout have a thickness, more than twice as great as those shown in the Ætna section; and, secondly, there is a marked dissimilarity existing between the lithological character of the strata. Especially is this true of the lower part of the section. It will be noticed, that that part of the Ætna section containing the three coal seams, consists entirely of shales; whereas



SEVEN-FOOT COAL SEAM ON THE NEW ENGLAND COMPANY'S PROPERTY,
NEAR NEW ENGLAND CITY, DADE COUNTY, GEORGIA.



no doubt, furnish valuable aid, in correlating the various coal seams of Sand and Lookout mountains. Until such evidence is obtained, no correlating, of any scientific value, is likely to be worked out.

As elsewhere stated, that part of the Upper Coal Measures lying above and including the Durham coal seam, appears to have no representative in the *Ætna* district. These upper coal seams seem to be a remnant of a once widely extended coal horizon stretching far to the north, and also probably extending to the south and west. Hayes, as previously noted, found representatives of these coals at Dayton; but they seem to reach a much greater development in Cross mountain, Campbell county, Tenn., near the Kentucky State-line, where, according to Safford, the Upper Coal Measures attain a thickness of more than 2,000 feet. Mr. Marius R. Campbell in his valuable paper on the Geology of Big Stone Gap Coal-fields of Virginia and Kentucky, after discussing at some length the literature upon the Southern Appalachian Coal-fields, adds in concluding his correlating notes, the following statement:¹ "Careful stratigraphic work is needed in the northern half of Tennessee, in the Briceville region, where the Upper Measures may be found; they may give the key to the stratigraphy in the Chattanooga region. Besides stratigraphic work, paleontologic work is needed at many points, but especially to determine the age and equivalence of the highest beds in the southern region; for, in that territory, the Upper Measures exist only in isolated remnants, and can not be correlated without the evidence of fossils."

¹ U. S. Geological Survey, Bull. No. 111, page 104.

CHAPTER VIII

CHEMICAL DISCUSSION OF THE COALS FROM LOOK- OUT MOUNTAIN, WALKER COUNTY, GA.

BY W. H. EMERSON, PH.D.,
Professor of Chemistry, Georgia School of Technology

The following analyses of Georgia coals were made by the Senior Class of the Georgia School of Technology, under the immediate supervision of the writer. Care was taken to avoid error, by having all work done in duplicate ; and, when duplicates failed to agree, the analysis was repeated, until agreement was reached. As a further check on accuracy, the analysis was repeated, when the heating value, calculated therefrom, varied more than one per cent. from the calorimeter value.

Little confidence was placed in the heating value of coals obtained from the analysis, until Mahler, in 1892, found very close agreement between the values obtained with the Mahler calorimeter and those by calculation, using Dulong's formula. The comparison was made on about thirty coals, mostly French. The formula used in calculation was:—

$$Q = \frac{1}{100} [81,400 C + 34,500 (H - \frac{O + N - 1}{8})],$$

in which C, H, O and N are the percentages of the elements symbolized by the letters, and Q is the heat of combustion of the coal in calories.

The accuracy of the method of calculation was more firmly

established, by the work of Lord and Haas on American Coals. They published, in the Transactions of the American Institute of Mining Engineers for 1897, analyses of about forty coals, mostly from Ohio and Pennsylvania, and found even closer agreement, than had Mahler, between the calorimeter and calculated values. They state that, in their opinion, the methods agree within the limits of error of analysis, and place the limit of probable error in their work at about one per cent.

Dulong's formula, as used by Lord and Haas, was $8,080 C + 34,462 (H - \frac{O}{8}) + 2,250 S$, in which C, H, O and S are the weights of the symbolized elements, in unit weight of the coal, and the sum is the heat of combustion of the coal expressed in calories. This formula was used in calculating the values given below; and it will be noted, that the values so obtained agree with the calorimeter, within one per cent.

The calorimeter used was the Mahler, manufactured by L. Golaz, Paris. The water equivalent was determined by the combustion of pure benzoic acid and naphthalene. The benzoic acid gave 481.2 as the average of 5 tests, using 6,322 as its heat of combustion. The naphthalene gave 484.8 as the average of six tests, using 9,628 as its heat of combustion. 483 units was taken as the water equivalent.

To measure temperatures, a Beckmann thermometer was used, graduated to hundredths, and permitting fairly accurate estimates to thousandths.

About one pound samples of the coal were obtained from Mr. S. W. McCallie, Assistant State Geologist. From this, after pulverizing, samples of fifty to one hundred grams were taken, and finely ground for the analysis and calorimeter tests. It was found, that accurate sampling for the analysis was much facilitated by passing the coal through a hundred mesh sieve.

A Glaser combustion furnace, about thirty inches long, was

used, provided with sheet iron gates underneath the trough, whereby the portion of the tube occupied by the boat could be protected from too early heating. Lead chromate mixed with red lead was used to absorb the sulphur. The absorbing train consisted of glass stop-cock U-tubes, with concentrated sulphuric acid for the water, and soda-lime for the carbon dioxide. The same absorbents were used in the purifying train. The sulphur was generally determined from the sulphuric acid in the calorimeter; though, in some cases, by the Eschka method. Nitrogen was determined by the Kjeldahl method.

The furnace and connections were tested by burning pure sugar, prepared by crystallizing rock-candy from alcohol, which gave almost the theoretical value for carbon and hydrogen.

	Carbon	Hydrogen	Water	Sulphur	Nitrogen	Ash
	1	2	3	4	5	6
I	85.75	4.63	.88	.79	1.44	3.17
II	86.97	4.44	1.06	.62	1.25	2.00
III	79.41	4.60	.93	.88	1.39	9.05
IV	85.07	4.48	.77	.88	1.50	3.42
V	84.32	4.72	1.21	.78	1.66	4.20

	Calculated Heating Value	Calorimeter	Difference	Difference Per Cent.	Heating Value per Gram of Combustion	Fixed Carbon, Ash and Moisture free
	7	8	9	10	11	12
I	8,366	8,415	-49	-.6	8,770	79.1
II	8,351	8,409	-58	-.7	8,675	78.4
III	7,821	7,763	+58	+.7	8,624	75.3
IV	8,234	8,290	-56	-.7	8,653	78.0
V	8,292	8,211	+81	+1.0	8,680	78.1

I Lump coal, Durham Mine, Walker County.

II S. T. Carson's property, Walker County. Vein 120 feet below Durham.

- III S. T. Carson's property, Walker County. Vein 180 feet below Durham.
- IV Washed coal, Durham mine.
- V Unwashed coal, Lookout Coal and Coke Company, Walker County.

In the table, columns 1 to 6 inclusive give the percentages of the various constituents. The hydrogen includes that from the water. Columns 7 and 8 give the calculated and calorimeter values, respectively, for the heat of combustion in calorics. These values may be converted into British thermal units by multiplying by $9/5$. Column 9 gives the difference between 7 and 8 in calorics; column 10, the percentage difference expressed on the calorimeter value. Column 11 gives the heating value per gram of combustible; i. e., the heat of combustion of one gram of the coal, ash and moisture free. Column 12 give the per cent. of "fixed carbon," ash and moisture free.

The last two columns show that all these coals belong to the same class, the differences not being greater than those, that might arise in coal from the same mine from difference of sample, combined with experimental errors. They fall in the lower part of the semi-bituminous class, whose heating value, according to Prof. Wm. Kent, ranges from 8,666 to 8,888 calorics, and whose fixed carbon ranges from 75 to 85 per cent.

This class of coals has the maximum heating value, being superior to the anthracites, because of their higher content of hydrogen, and superior to the other bituminous coals, because of their lower content of oxygen.

These should be good steam coals and good coking coals. Number I is very similar to the Pocahontas of Virginia in composition and heating value.

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